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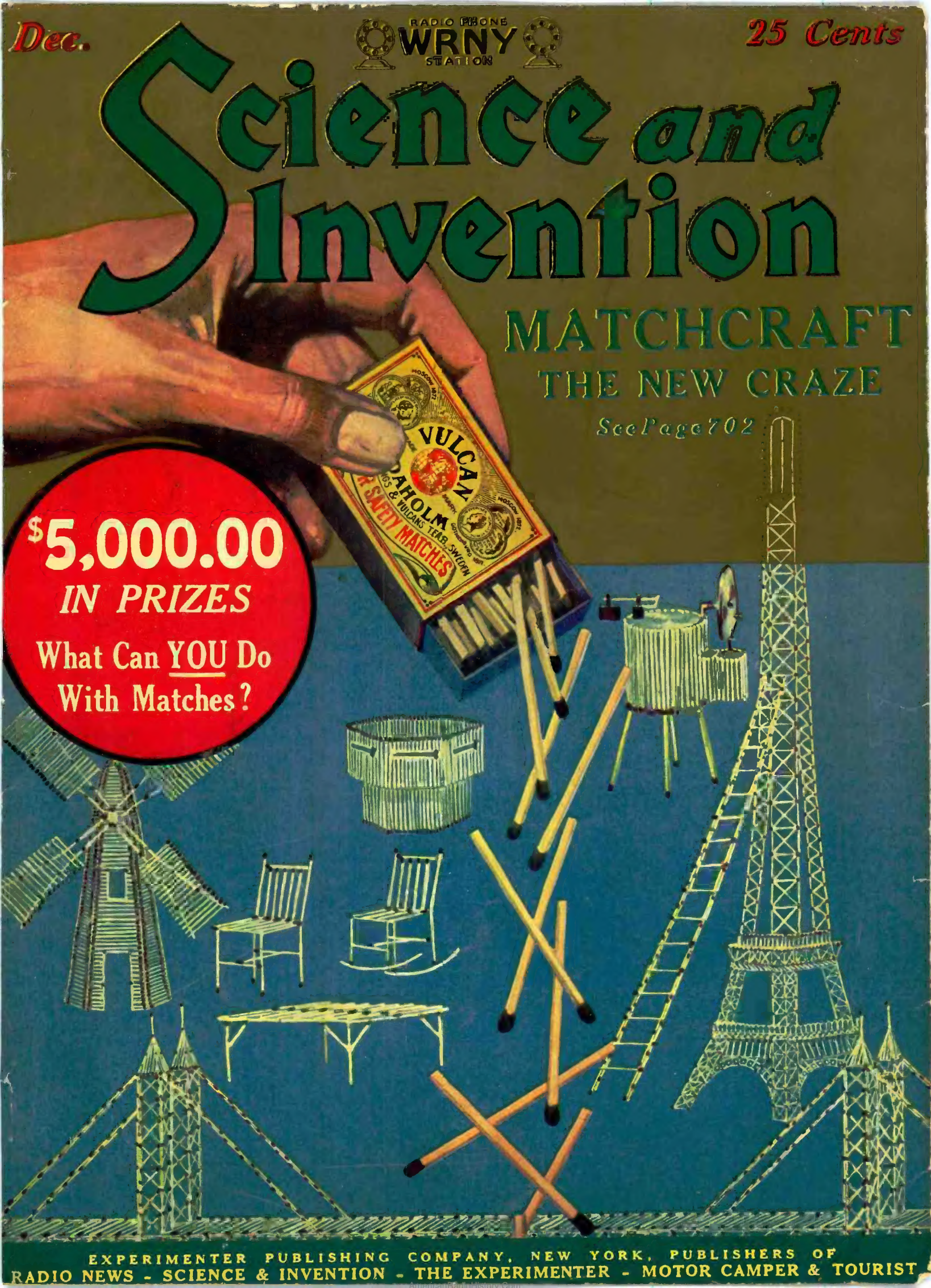

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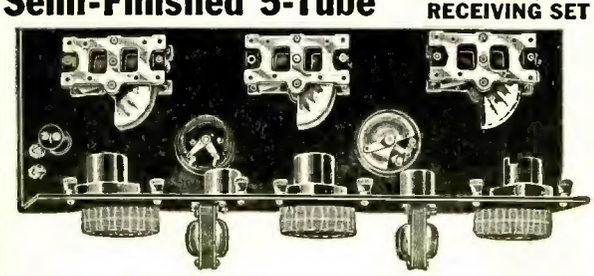

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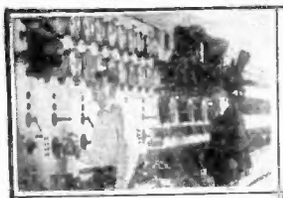

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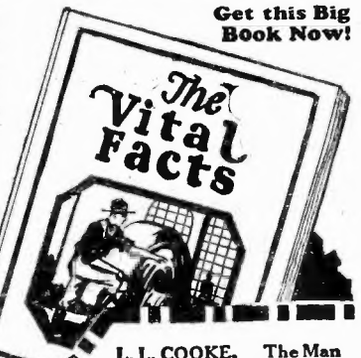

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King Winter Foiled By Science

Every winter, traffic in the harbors of temperate and northern countries is usually tied up for some length of time by ice blockades. An article will show how science can be applied to eliminate this great loss of time.

How Air-Ports of the Future May Look

A full page futuristic drawing will clearly show how the self-contained airship terminals may appear.

Where Do You Weigh Most?

Some interesting disclosures, based on the laws of gravity, will show differences in weight of an object in various places.

An Entirely New Brain Teaser

Everyone is more or less interested in problems of all kinds. We are going to present a new type that is as interesting and absorbing as it is novel.

Can Radio Sets Be Used on Alternating Currents?

Yes, if a properly designed and constructed rectifying and filter system is used. A manufactured set operating entirely from A.C. will be described.

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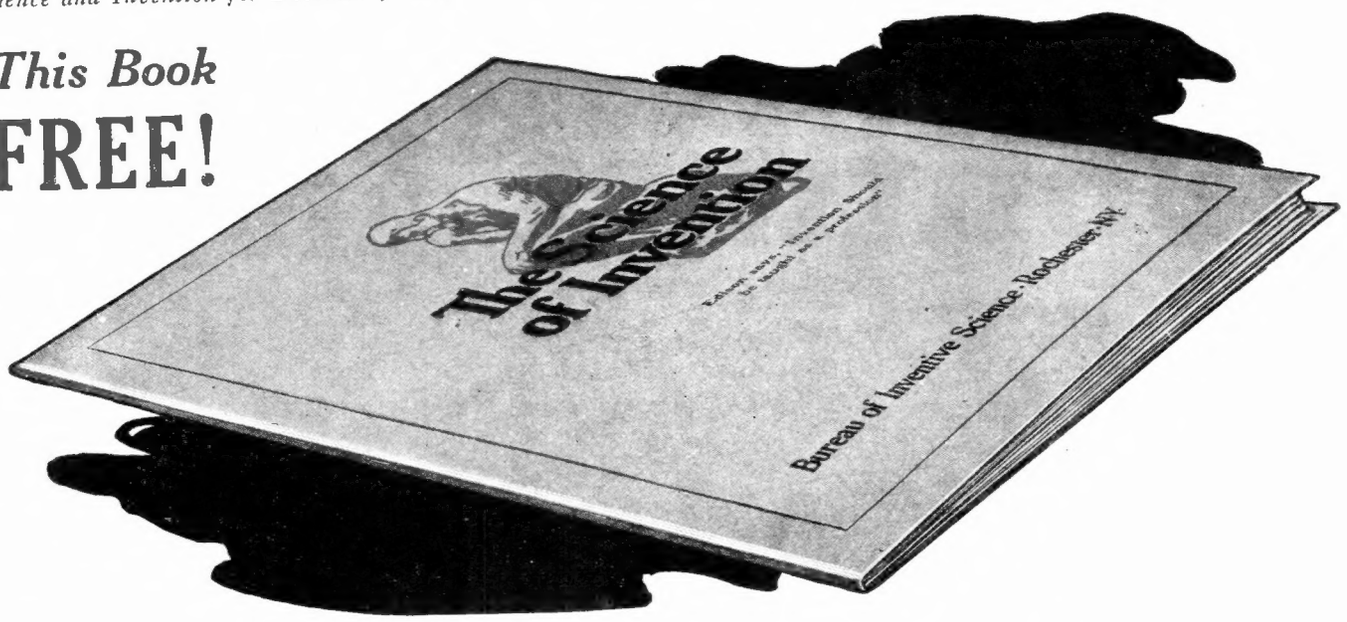

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Treatment Won't Cost You One Cent
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Founder of Merke Institute
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Save Yourself From Baldness. Stop Falling Hair. Here is Your Contract—Grow New Hair in 30 Days Or This Trial Won't Cost You One Cent.

By ALOIS MERKE

Founder of Famous Merke Institute, Fifth Avenue, New York

THAT'S clear, isn't it? I make no conditions. No matter how fast your hair is falling out, no matter how much of it is gone—this offer stands. I don't care what treatments you've tried without results. Scalp foods, massages, tonics—here is a new scientific system that will give you a new head of hair—or I pay the whole cost of the treatment myself.

How am I able to make this amazing offer? The answer is simple. The Merke System of hair growth is founded upon a very recent scientific discovery. I have found during many years of research and experience in the Merke Institute, Fifth Avenue, New York, that in most cases of baldness, the hair roots are NOT dead. They are merely dormant—asleep!

It is an absolute waste of time—a shameful waste of money—to try to penetrate to these dormant roots with oils, massages and common ordinary tonics, which merely treat the surface skin. You wouldn't expect to make a tree grow by rubbing "growing fluid" on the bark—you'd get at the roots.

And that is just what my scientific system does. It penetrates *below* the surface of the scalp. It stimulates the dormant *roots*. It wakens them. The tiny capillaries begin to pump nature's own nourishment into them. Hair begins to grow again. It takes on body and color. No artificial hairfoods—no rubbing. And here's the wonderful thing about this system. It is *simple*. You can use it at home—in any home that has electricity—easily—without the slightest discomfort.

Here's Proof!

"The condition of my hair was very bad. After six weeks' treatment with the Thermocap my head was covered with short hair and it was no longer dull and lifeless. I kept up the treatment and in return I have as good a head of hair as any one could wish."
CLARENCE TERPENING
158 South Cedar St., Galesburg, Ill.

"I used the Cap for 30 days when to my great surprise I could see a new coat of hair coming and now my hair is very near as good as it was when it first started to come out."
J. C. REGAN
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"Your Thermocap has done a wonderful thing in bringing back my hair where all other things had failed. The top of my head is now entirely covered with hair after using the Thermocap for about two months, and new hair seems to be coming in all the time."
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21 Hampton Place, Utica, N. Y.

This Is Your Bona-Fide Contract

Thousands of men and women have been treated successfully at the Merke Institute. Hundreds daily are getting amazing results with this easier, less expensive "at home" system of hair growth. Now, I do not say that all cases of baldness are curable. There are some that nothing in the world can help. Yet so many men and women write in daily about the wonderful results that I gladly make this offer. Here is your contract—try this remarkable treatment for 30 days. Then if you're not simply delighted with the new growth of hair—write me at once. Say that my system hasn't done all I claimed for it—and I'll see that the 30 day trial doesn't cost you one cent.

Free Booklet Tells All

There's no room here to tell you all about your hair—and about the amazing contract I offer you. But I will be glad to tell you all if you are interested. It's free—absolutely without any obligations. Just mail the coupon and I will send you, without cost, a wonderfully interesting booklet that describes in detail the system that is proving a boon to thousands in this and other countries. Mail this coupon and the booklet will reach you by return mail.

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Please send me—without cost or obligation—a copy of your book, "The New Way to Grow Hair," describing the Merke System.

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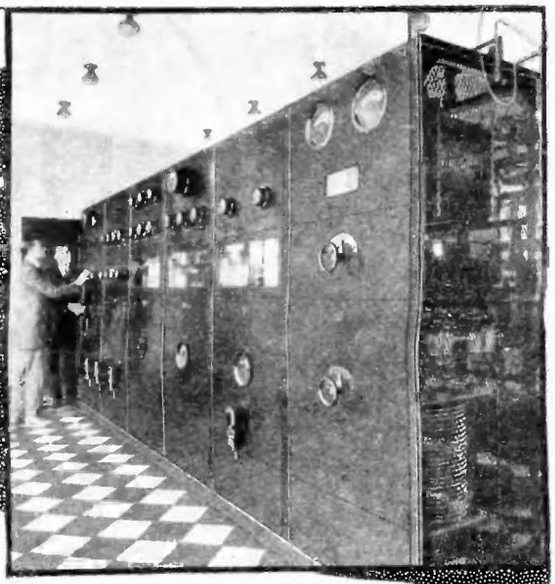

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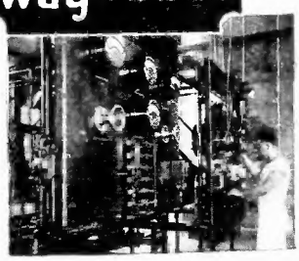

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U. S. Government now spends millions developing, using Radio. Ex-Postmaster General Hays said: "Probably the biggest part in the future of the postal service will be played by Radio." Photo above—sending out time signals at Arlington, great Government Radio station at Washington—Radio is fitting new uses, filling new needs never dreamed of before. Radio Experts are in greater demand than ever.

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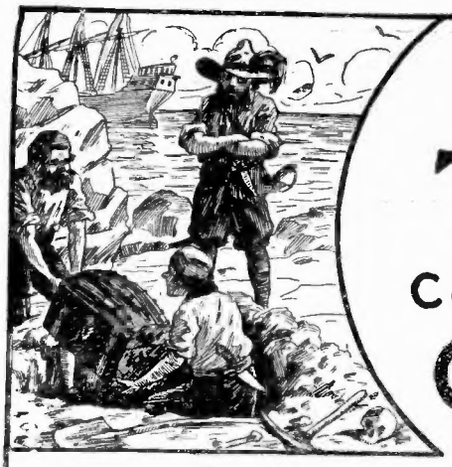

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I have not written since I received the big set. I can still say that it far exceeded my anticipations. Since I have been studying with your school I have been appointed chemist for the Scranton Coal Co. testing all the coal and ash by proximate analysis. The lessons are helping me wonderfully, and the interesting way in which they are written makes me wait patiently for each lesson.—MORLAIS COUZENS.

I wish to express my appreciation of your prompt reply to my letter and to the recommendation to the General Electric Co. I intend to start the student engineering course at the works. This is somewhat along electrical lines, but the fact that I had a recommendation from a reliable school no doubt had considerable influence in helping me to secure the job.—H. VAN BENTHUYSEN.

So far I've been more than pleased with your course and am still doing nicely. I hope to be your honor graduate this year.—J. M. NORKUS, JR.

I find your course excellent and your instruction, truthfully, the clearest and best assembled I have ever taken, and yours is the fifth one I've studied.—JAMES J. KELLY.

From the time I was having Chemistry it has never been thus explained to me as it is now. I am recommending you highly to my friends, and urging them to become members of such an organization.—CHARLES BENJAMIN.

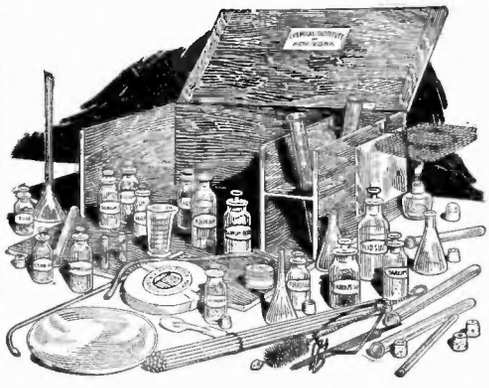
I shall always recommend your school to my friends and let them know how simple your lessons are.—C. J. AMDAHL.

I am more than pleased. You dig right in from the start. I am going to get somewhere with this course. I am so glad that I found you.—A. A. CAMERON.

I use your lessons constantly as I find it more thorough than most text books I can secure.—WM. H. TIBBS.

Thanking you for your lessons, which I find not only clear and concise, but wonderfully interesting. I am—ROBT. H. TRAYLOR.

I received employment in the Consolidated Gas. Co. I appreciate very much the good service of the school when a recommendation was asked for.—JOS. DECKER.



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S.I., Dec. '25

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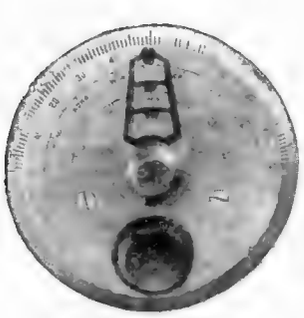

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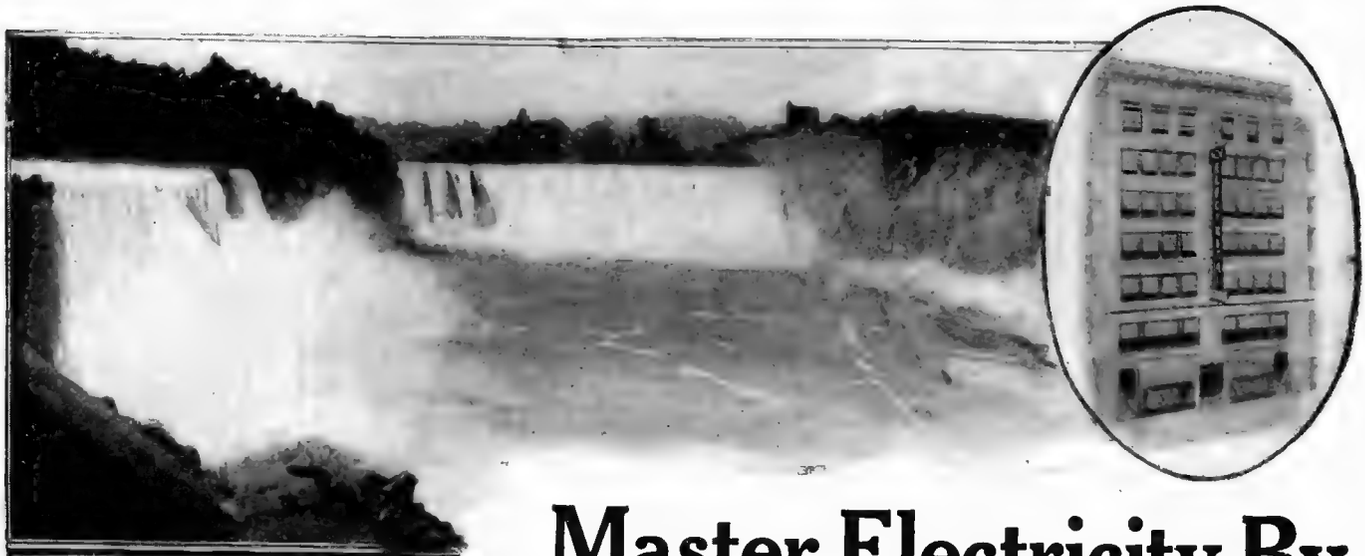

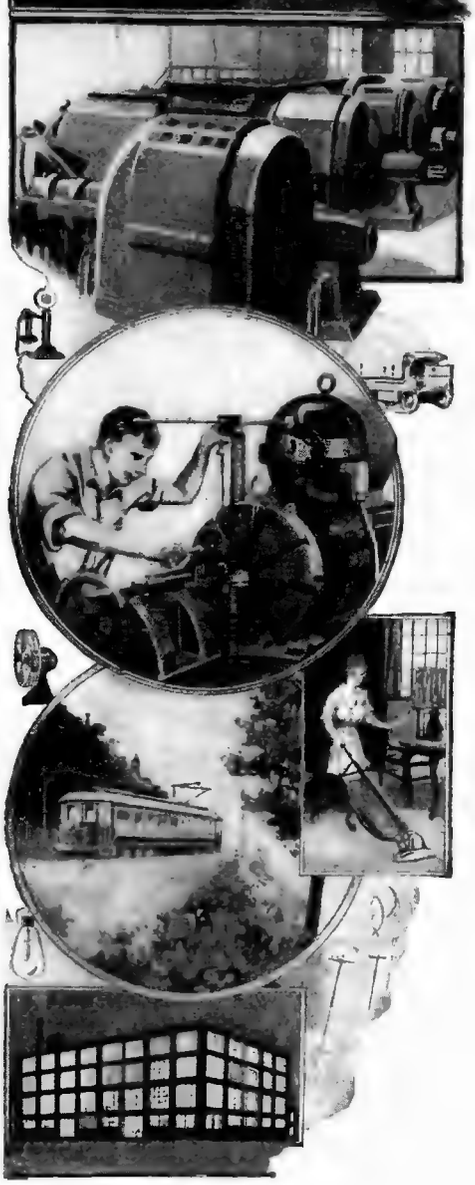

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Science and Invention

December, 1925
No. 8

Editorial and General Offices, - - - 53 Park Place, New York

"Those Who Refuse to Go Beyond Fact Rarely Get As Far As Fact" - - - HUXLEY

How Science Affects Our Lives

By HUGO GERNSBACK

IF you stand with your face close up to a painting, it is impossible to get a good view of it, as you have no perspective of the painting. A fish swimming in water is not aware of the fact that there is water surrounding him. A young child is not conscious that it is surrounded by air on all sides.

These trite remarks lead up to the fact that we of today are immersed in an age of science to such an extent that we no longer are conscious that science affects us at every hand and in a myriad of different ways; all of which we do not observe any longer, because we have become so thoroughly accustomed to them.

I BELIEVE THAT:
our present civilization is upheld only by thin gossamer threads of science.

During the last 150 years the world has seen more progress due to science than it saw practically for the entire time that went before—that is to say, as far as human beings are concerned, a stretch of some 150,000 or more years.

Picture the astonishment, if you can, of your great-great-grandfather suddenly brought into our present-day civilization. It probably would be impossible for him to live the same life as we do today, because he was not brought up in the atmosphere of the science of our era.

I BELIEVE THAT:
while science speeds up our lives, it also brings us untold advantages.

When we speak of science, we refer to anything and everything that has to do with scientific advance,—Electricity and its millions of uses and adaptations, mechanics and its millions of different ramifications, throughout the world.

The strangest part, and the one which few of us realize at any time is that our present civilization, built upon the science platform, is of great frailty. Take such a comparatively simple thing as transportation. Suppose all railroads, steam and electric, as well as all automobiles, should suddenly cease to function for as short a period as six months. The whole world would immediately be thrown into turmoil and life could no longer go on. People in large cities would either starve to death or have to walk back to the country, because there would be no way to bring the food to them; even going back to horse-and-wagon would not help—quite the contrary, it would make it worse.

Our cities and population have grown to such tremendous sizes that the horse-and-wagon would never be adequate to furnish food and other commodities quickly enough. Witness the fact today of any highway, which is mostly choked with the tremendous truck traffic moving at the rate of from 25 miles an hour upwards. Then take a horse-drawn vehicle, going at five miles an hour, and figure out what would happen.

I BELIEVE THAT:
science is the cure-all for most of our everyday ills.

Take our communication systems — the telegraph, the telephone, and radio. Wipe these out also for a six-month, and see what would happen. Commerce would be at a standstill, and there would be general chaos. The suppression of the telephone would not be all—the new condition would then mean that we would either have to walk or ride in horse-drawn carriages—a condition which you can readily imagine in your mind as being impossible, as far as our present-day lives are concerned. Take away electricity and steam, and our present buildings and houses would become untenantable.

These are only a few random selections, leaving out thousands of other scientific accomplishments that have come into vogue during the last 150 years. But even with the few mentioned, it will be seen that we would retrograde immediately several centuries, and after most of our population had died of starvation, plague or what not, the world would go back to where it was centuries ago, and remain in a much worse condition than it was at that time, because our ancestors of that period had become used to existing conditions and had accommodated themselves to these. They would be lost in our environment.

THE GOLDEN AGE OF SCIENCE
is symbolized by the golden cover
OF SCIENCE & INVENTION,
LOOK FOR THE GOLD COVER
every month!

Mr. Hugo Gernsback speaks every Monday at 9 P. M. from Station WRNY on various scientific and radio subjects.

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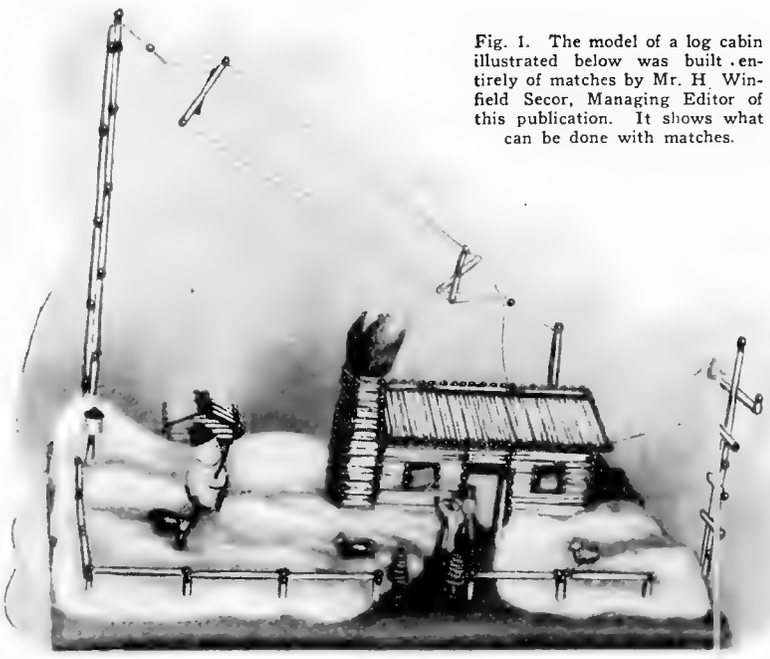

Fig. 1. The model of a log cabin illustrated below was built entirely of matches by Mr. H. Winfield Secor, Managing Editor of this publication. It shows what can be done with matches.

MATCHCRAFT

the Latest Craze

By HUGO GERNSBACK

Member American Physical Society.

HERE is a new and intensely interesting craze originated by the writer, which bids fair to become famous over-night, from all present indications. Here is a brand new craft that can be easily mastered by the youngest, as well as the oldest, of our readers. It is one of the most fascinating pastimes that has appeared within recent years, and is exceedingly simple.

The new craze is best explained in the question: **"What can You Do With Matches?"** The idea is to fashion or make from matches, various models in miniature or in life size. You can build the simplest things with matches, from a doll's chair to a skyscraper five feet high. You can build bridges, towers, houses, and a myriad of other things, some of which we have tried to show in the accompanying illustrations, all of which were built by the staff of SCIENCE AND INVENTION Magazine.

$5,000.00 Prize Contest

FOR the next twelve months, SCIENCE AND INVENTION magazine will award a total of $5,000 in prizes, in a new contest. You are asked to make models, fashioning the same entirely from safety matches. Please read the text of the Matchcraft article carefully and observe the following simple rules:

(1) Models submitted must contain at least 90 per cent. safety matches in their construction.

(2) Models made of toothpicks, paper matches, or non-safety matches, are not eligible in this contest.

(3) Models can not be built around boxes or other supporting articles. Walls, roofs, etc., must all be self-supporting and made of matches.

(4) All liquid adhesives, such as glue, shellac, cements, etc., are permissible.

(5) Models may be painted, gilded or silvered.

(6) Models may be of any size.

(7) In order to win a prize, it is necessary that either models be submitted, or, if this is not practical, owing to their size, a photograph (large-sized) of the model may be sent in lieu of the model itself. The best models submitted each month will be awarded the prizes scheduled herewith.

(8) All models submitted to SCIENCE AND INVENTION Magazine will be promptly returned to the builder, who will prepay all charges.

16 Monthly Prizes

First Prize	$100.00
Second Prize	75.00
Third Prize	50.00
Fourth Prize	35.00
Fifth Prize	25.00
Sixth Prize	20.00
Seventh Prize	15.00
Eighth Prize	12.50
9th to 16th Prizes of $10.00 each	$80.00

(9) Where SCIENCE AND INVENTION has any doubts as to the model (where photos only are submitted) complying with all the regulations, the judges may, at their discretion, request that the actual model be sent in for inspection, paying transportation charges both ways.

(10) This is a monthly contest, lasting for twelve months, each monthly contest closing on the first of the month following date of issue. This contest for the month of December will close January 1, 1926, and prize winning announcements will be made in the March, 1926, issue.

(11) Models must be shipped in a strong wooden box, never in a cardboard box, as SCIENCE AND INVENTION can not be held responsible for breakage in transit due to models having been improperly packed.

(12) When models are sent, be sure to affix tag, giving your name and address, to the model itself. In addition, put name and address on outside wrapper of package.

(13) When photographs are submitted, it is necessary that they be at least 5" x 7", not smaller, and that your name and address appear on the back of each photograph.

(14) In this contest, manuscripts or description of the models are not required unless the model contains something unusual requiring explanation. Keep all descriptions short.

(15) Address all letters, packages, etc., to Editor, "Matchcraft" Contest, care SCIENCE AND INVENTION Magazine, 53 Park Place, New York.

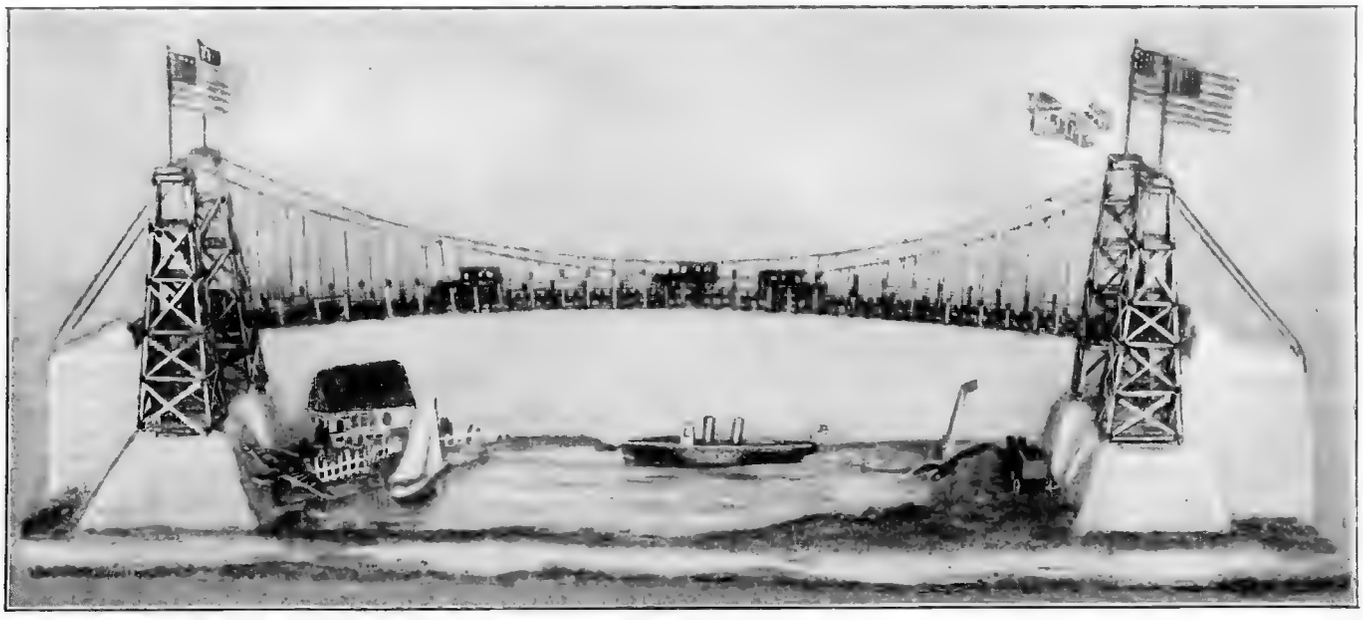

Fig. 2. The model illustrated above was also built entirely of matches and it is typical of the type of material which we expect of the contestants competing in the $5,000.00 matchcraft contest. Notice how the birds and the airplane seem to be flying. We are not, however, interested in all the superfluous decorations, but desire models made entirely of match sticks. This particular one was built by Joseph H. Kraus, Field Editor.

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The technique of Matchcraft is exceedingly simple, but certain rules must be observed. In the first place, only the so-called safety matches should be used, for obvious reasons. Matches that strike on ordinary surfaces should never be used in any Matchcraft models on account of the fire hazard. Nor can paper matches be used. The only things required in building Matchcraft models are a razor blade with holder—or a sharp knife—a good, quick drying glue, such as Ambroid or thick Sure Grip, which two have been found best from experience, although shellac and ordinary glue can be used, but may take much longer to harden; also a few strips of adhesive tape, which is used as shown further on. The razor blade or sharp knife is used to cut off the heads of the matches if necessary, or to otherwise trim the matches to size as required.

One of the most important considerations of Matchcraft is that at least 90 per cent. of each model must be made out of matches. When building a house, or other object, it is never permissable to use a cardboard box or a wooden box, or other supports, as the background, and simply glue the matches against it. This would defeat the aims and purpose of Matchcraft. The requirement of the new art—if we may call it such—is that whatever is fashioned from matches should carry itself, *using matches only.*

For instance, the house shown in Fig. 1 was made entirely out of matches, nothing else having been used, the entire house being self-supporting. Of course, the surrounding objects, such as, for instance, the snow, which was cotton, have nothing to do with the Matchcraft, and were used simply to give a little scenic effect. The radio mast and power-line pole are fashioned entirely from matches.

The same is the case with the bridge shown in Fig. 2. Here we have a bridge span actually more than two feet long. Only matches, nothing else, were used for the towers and span, while the cables supporting the arch were made of threads and thin strings. From this it will be seen that over 90 per cent. of the bridge consists of nothing but matches, despite its great size. The supporting piers, as well as the lake (which is nothing but a mirror), and the boats, etc., are simply contributing scenery, but the main article—namely, the bridge itself—is made of matches.

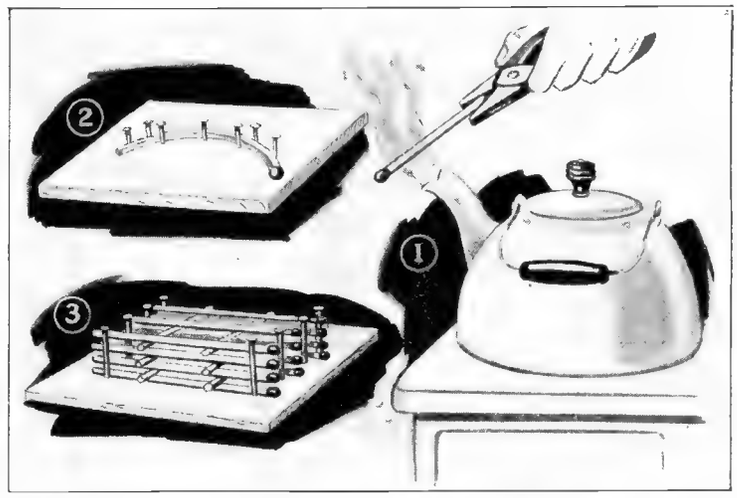

Fig. 3. This illustration shows how matches may be steamed and bent, and also indicates how a lattice structure may be quickly built. Note the nails driven in the boards for holding the matches in place while drying.

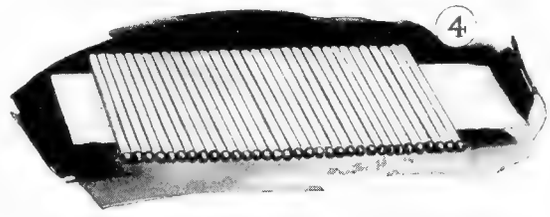

Fig. 4. Matches may be fastened to a strip of adhesive tape and the glue may be applied while they are held in this position. When dry the adhesive tape may be removed.

The automobiles on the bridge were small toy models of tin. The same holds true of all the other models, such as Fig. 11, a radio tower and the small power house, made entirely of matches. The towers in this case were 16½ inches high.

Fig. 12, the radio outfit, was also made of fully 90 per cent. matches, the dials being ordinary buttons. These buttons could, of course, have been fashioned out of wood and made to appear more like dials, and we are showing this only as an example of what can be done.

The windmill, Fig. 13, on the other hand, again was fashioned entirely out of matches, including the vanes. In this case a long needle was used as a pivot, and the windmill actually is a working model—the vanes rotate when blown against by a fan.

The same is the case with Fig. 14, showing a floating derrick, which is also movable, the house on the float actually turning around, and the shovel being movable as well. With the exception of the string, the entire model is made out of matches. The supporting background—namely, the water and the land—was made out of plaster of Paris, the land being of plaster of Paris as well, but before it hardened, some bird gravel was sprinkled over it, giving a dark color.

Match puzzles are not eligible.

There is a certain technique which the staff of SCIENCE AND INVENTION has found to work best when trying to build models of this kind, and this technique is given herewith. If it is carefully followed, it will be found that we have here a most entrancing and remunerative new hobby.

"Matchcraft" Technique

By the Editorial Staff of Science and Invention

THE technique for building models entirely of matches is rather simple, particularly after a few fundamental details have been learned. If a large structure is to be built, it is advisable to glue matches together in groups of twos, threes or fours to serve as the main girders. The procedure was to apply a small amount of Ambroid, an especially quick-drying glue, to one side of the match. Another match was then picked up and pressed against the glued portion, but care was taken to see to it that the heads of the matches were staggered. This procedure is illustrated in the photograph in Fig. 6, where the reader can see the glue being applied. Notice that in the foreground there is a double row of matches. These have all been cemented together and the match to which the glue is just being applied will be laid down and pressed to the already existing row, increasing the length of the column. The completed structure is more clearly brought out in Fig. 1, where the photograph shows the radio mast built in this manner. Notice how the matches are staggered. Staggering them in this fashion permits of a perfectly straight, solid girder, or mast, which will not bend or buckle. The heads of the matches do not have to be cut off in order to permit of a straight girder, inasmuch as the slight bulge produced by the head in one group of matches is compensated for by the second group. This particular type of beam was used as the corner brace for each of the towers in the bridge, was used as the foundation for the houses and was used as the main support of the span of the bridge. Beams thus formed were also used as the main uprights of the radio tower and the foundation for the sea-going derrick and its arms. The main idea then is to build the girders upon which the rest of your structure is to be assembled. While one of these beams is drying you can be building the other. In about fifteen minutes the entire group will be ready for use.

When using Ambroid as a cement, it will be found that even though the matches do not apparently hold together because of

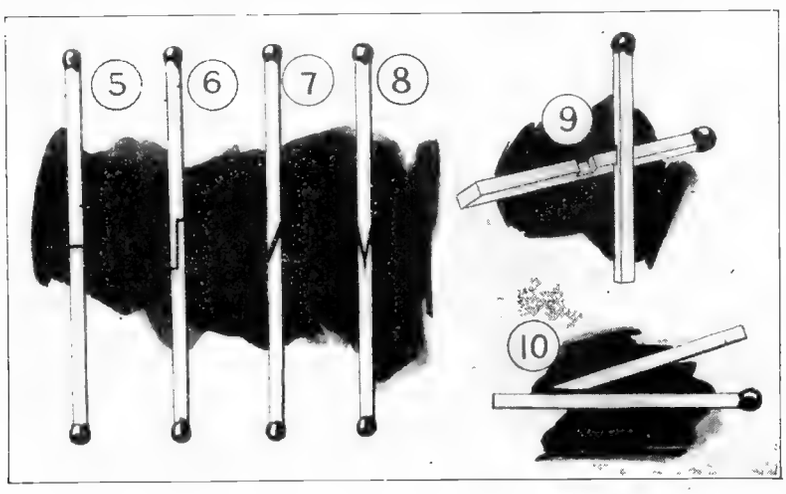

Fig. 5. Here a number of match joints are illustrated. The contestant will find that it is a rather simple matter to make any of these joints and with the exception of the joint shown in 5, all of the other joints are quite sturdy.

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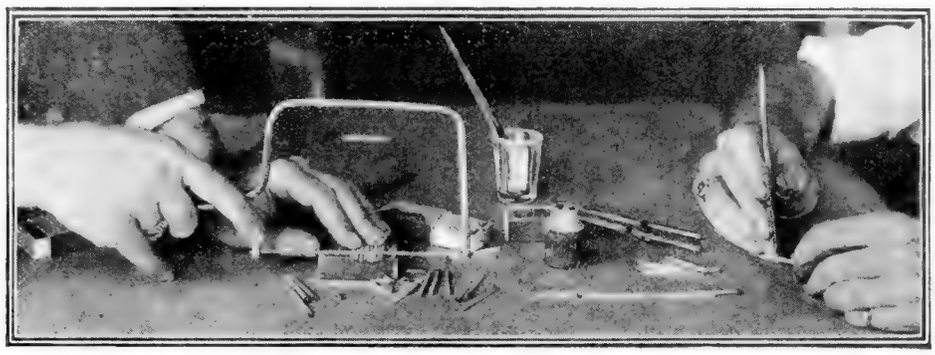

Fig. 6. This illustration shows how matches may be glued together to form beams or girders and also how a group of matches when cemented may easily be cut to size.

Fig. 7. The interesting match novelty at the left walks along the knife. Build one and try it.

some defect in your manipulation of them, you can apply a little more of the cement to the spreading surfaces, which cement upon drying, will pull those surfaces together. So strong is a simple girder constructed of these matches that under actual test *a load of twelve pounds was applied* across a simple girder before it broke. Undoubtedly a hundred pounds or more could be applied to a structure without breaking it down if the load were supported from the end of the girder rather than on the line of least resistance.

When joining a great many matches together to form the wall of a house or the side of any particular object, the simplest procedure is to place all these matches on a strip of adhesive tape, which holds them in place. A thin coat of Ambroid, shellac, varnish or any hot or cold glue is then applied over the entire surface of the matches held by the adhesive tape. Cross-braces may then be put on top of the soft cement, but unless the heads of the cross-braces are cut off, the union will be imperfect, due to the slight bulge produced by the match heads. When this object dries, it may be removed from the adhesive tape in one unit and easily put in place on the structure which is being built. This, of course, is merely a suggestion. The procedure is shown in Fig. 4.

Several other kinks may be interesting to note before proceeding with regular construction details. Matches may be bent, particularly if care be taken to select straight-grained matches, of which several will be found in every box, by holding the match in a jet of steam issuing from an ordinary kettle placed on the stove. When the match is well steamed, as illustrated in Fig. 3, it is put between nails, which are hammered into a board conforming with the desired curvature. This is shown in illustration 2 of Fig. 3. Illustration 3 shows a simple method of constructing a lattice structure, nails holding the matches in place while they are drying. This greatly expedites the building of a structure.

Let us now look at Fig. 5. Here are shown various methods for making joints. The matches may be cut and cemented together, as illustrated in Numbers 5, 6, 7 or 8, of Fig. 5. No. 9 of Fig. 5 shows a method of making a dove-tailed joint, and 10 a method of making an angular joint. This latter joint is used particularly in the construction of the larger girders. Only for thin masts or poles are the joints in 5, 6, 7 or 8 employed.

After a number of matches have been cemented together and it is desired to use them for the roof of a building, it may be found that these matches will be too long for the purpose. They may, nevertheless, be cemented into place, and after the object has dried, a small coping saw, a fine-toothed keyhole saw, a scroll saw or hack-saw may be used to cut off the projecting parts of the matches. The edges may then be sandpapered, giving a fine finish to the structure. It is advisable to shellac or varnish all completed models to prevent match heads from loosening, due to dampness. This should be done after the model has been completed. Matches may be cut to size by means of a sharp knife, a safety razor blade held in a suitable holder, a sharp chisel, a photographic print trimmer or a pair of scissors.

Let us now proceed to outline the method used in the construction of the various objects illustrated on these pages. The model Fig. 1 was built entirely by Mr. H. Winfield Secor, Managing Editor of SCIENCE AND INVENTION Magazine. After a suitable foundation and after the struts were all put in place, a quantity of cement was applied to two of the struts, and the matches were laid in place one after the other in rapid succession. Some cement was then added to two adjacent struts and so layer upon layer of matches were built up. When the windows were reached the matches were cut to shape by a pair of scissors and the heads of alternate matches were turned inward to outline the frame of the windows and doors. The roof of the house was then laid in place, as the photograph shows, and then the chimney was built. Here upright structures were cemented over the already completed side, and the matches were then glued to the uprights. The smoke issuing from the chimney is ordinary cotton which has been blackened by brushing it with a tooth brush dipped in India ink. A door was then built, also entirely of matches, and suitably cross-braced to add strength, which was pivoted at the top and bottom by means of small wire hinges. The antenna mast was then constructed and was set into the base. The current supply pole was also built of matches. Note that the insulators on the poles are merely short pieces of matches, and the heads of these matches make good-looking insulators. Two crosses were then made for the cage-type antenna, which, in this particular case, is made of fine magnet wire. The heads of matches act as insulators for the antenna. The model has a miniature incandescent light installed, which illuminates the interior of the cabin and

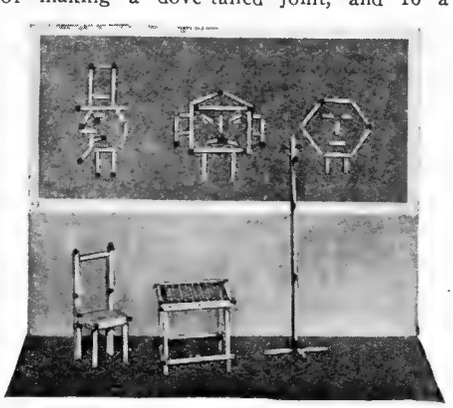

Fig. 8. The furniture illustrated above was made by Mr. Peck. The blackboard was decorated by Mr. Secor. These two groups of devices are very interesting toys for your daughter's doll house.

Fig. 10. The photograph below shows Mr. Kraus busy on the bridge model. Note particularly the size of the bridge. Models in this contest can be of any size desired. In shipping models to the editors it is advisable to tie them fast in their crates to prevent damage.

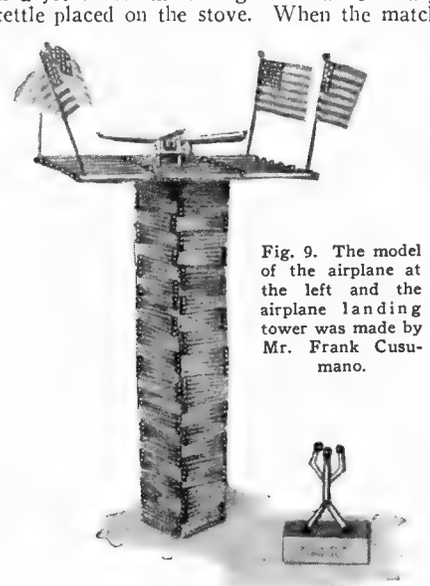

Fig. 9. The model of the airplane at the left and the airplane landing tower was made by Mr. Frank Cusumano.

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sends its rays out through the windows and doors. A flashlight battery connected with the bulb within the model completes the arrangement. Of course, the lamp is not a part of the model. That is merely a dressing added to lend realism, as is the snow in the foreground, the snow man in the yard and the evergreens near the entrance of the house. The house itself, the mast, cross-braces on the antenna, the smokehouse in the back yard, the high-tension line pole and the fence surrounding the entire lot were made entirely of matches.

THE "MATCH"-LESS BRIDGE

In the construction of the bridge, two long girders, each 30 inches long, were first made. These were permitted to dry while 16 short girders, each 7½ inches long, were laid down. The procedure in the construction of these girders was the same as that in the construction of the antenna mast in Fig. 1. While the upright girders for the corners of the towers of the bridge were drying, two 30-inch girders were laid on the table and held in place by suitable weights at both ends. Matches were then cemented across these girders, forming the walk or roadway of the bridge. These were spaced one-eighth of an inch apart. While this was drying the towers were started. On each pair, the top and bottom cross-braces were first put in place, and several other cross braces were then added. The diagonals were then cemented in place and the builder thus completed eight tower sections, two for each tower. Two wooden blocks were now cut to the desired size and held between two of the tower sections by means of rubber bands, while the cross-braces to complete the tower were added. When two towers had been finished they were joined together at the top and 2½ inches from the bottom to rest the roadway of the bridge upon and to act as the supports for the cables. Half-lengths of matches were then glued in place to serve as guards or fences. Upon these, thread was wound back and forth in a zig-zag fashion, making a very serviceable looking fence. The roadway was turned upside down and cross-braced by means of matches and then rested upon the structure between the two supporting towers. Two pieces of fishline were then tied to the top of the tower, and the center of the bridge was raised by spreading the towers apart. When the proper curve had been obtained, the roadway was fastened with thread to the supporting structure. A great number of threads were then tied to the fishline cable. They hung about six inches below the roadway. A tiny globule of glue was then put upon the roadway at the exact point where these threads intersected the roadway, and the thread was held in place long enough for the glue to dry. This procedure was resolved upon after it was found impractical to tie the thread to one cable, permit it to come around under the bridge and tie it to the corresponding cable on the opposite side, because when such a method was started and the slack was taken up in one part of the thread, another thread loosened. By employing the glue fixation method each thread was taut. When the entire bridge was completed the supporting structure of plaster of Paris was built.

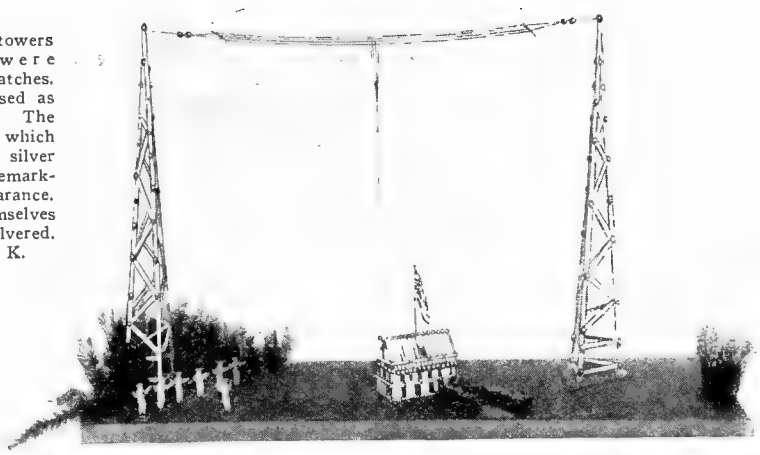

Fig. 11. The radio towers and the barracks were built entirely of matches. Match heads are used as antenna insulators. The aerial is of thread which was painted with silver paint giving it a remarkable sparkling appearance. The towers themselves were likewise silvered. Model by J. H. K.

Discarded match boxes were used under the plaster of Paris to serve as a foundation for the laying on of this plaster, and first a very rough outline of the foundation was built which was finished up by a later application of the plaster. The lake or river was outlined by plaster of Paris upon which bird gravel was sprinkled before it dried. The ships are set on a looking glass which serves as the lake, and pins fastened to the very end of the wings of the paper birds, as well as from the end of the paper airplane, suspend the birds and airplane in the air. Using this method of mounting, it appears as though the plane is supported by no visible means. This model was built by Joseph H. Kraus, Field Editor of SCIENCE AND INVENTION Magazine. Fig. 10 shows the author at work upon the device.

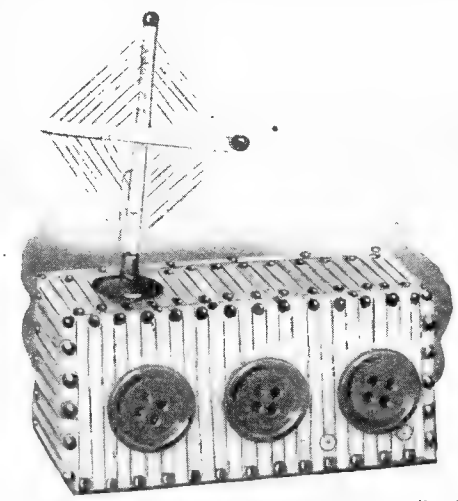

Fig. 12. Above we find a small radio set built of matches. Of course, it is merely a model and doesn't work. The loop is wound with green silk thread and stands on a button. More than ninety per cent. of the model is of matches.

Two cross matches and one upright match glued together form the straddling image held upon the knife in Fig. 7. Ask your friends to hold the knife steadily so that the legs of the figure just barely touch the table, and you will find that the match actually walks along the edge of the knife. If the match is reversed, it will start to walk toward the hand. The walking is due to the impossibility of holding the knife absolutely steady.

Fig. 13. The interesting windmill illustrated here was built by Mr. Joseph F. Odenbach. The vanes are mounted in a cork into which a knitting needle has been pushed. The vanes rotate freely when the wind catches them.

The furniture in Fig. 8 was built by Mr. A. P. Peck, Radio Editor of SCIENCE AND INVENTION Magazine, and Mr. H. Winfield Secor decorated the blackboard in the background by means of match figures. These are interesting little adjuncts to any doll house. The airplane and airplane landing stage in Fig. 9 were built entirely of matches by Mr. Frank Cusumano.

The radio towers and the barracks were built by Mr. Kraus. These are shown in Fig. 11. The breaking strain of these towers, when the weight is applied across the structure, is 12 pounds. The antenna in this case is made of thread, although wire

(*Continued on page* 770)

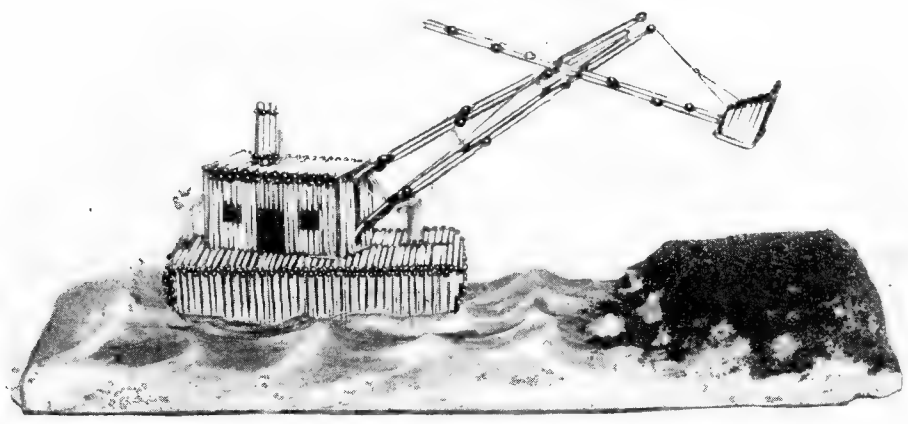

Fig. 14. The model illustrated above was built by Mr. A. P. Peck. The bucket of the derrick is movable, and the engine house on the boat also moves. The foreground and the water are made of plaster of Paris suitably colored.

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Bridge Is Great Engineering Feat

The highest steel bridge in France is that known as the Garabit Viaduct that connects two mountain chains in the Izere Valley. This bridge is most remarkable because of its simple construction and also because of the departure from the usual types of bridges. This structure is almost as high as the Woolworth Building, as our illustration shows, it being 750 feet from the bottom of the valley to the roadway.

The arrows in the illustration above indicate stairways and ladders that make every part of the framework of this remarkable bridge easily accessible for inspection, painting and repairing. The entire span rests on four concrete abutments.

The entire secret of the strength and simplicity of this type of bridge construction inheres in the fact that a cylinder is the strongest mechanical structure that can be made. Therefore, of course, a semi-cylinder is also very strong. The small diagram of the bridge that is shown in the insert indicates by the arrows the various points of strain. Note how the central strain is distributed.

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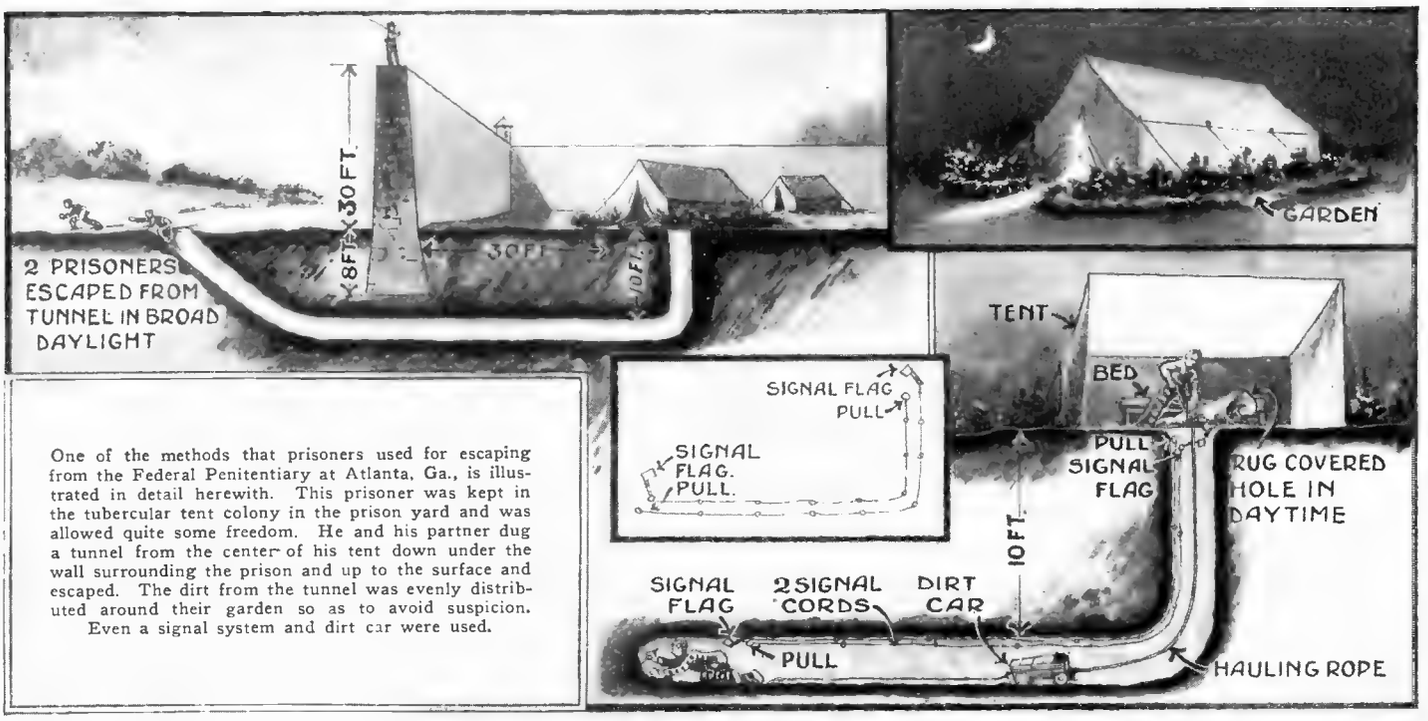
Science in Prison Escapes

By JOSEPH FULLING FISHMAN, Prison Investigator



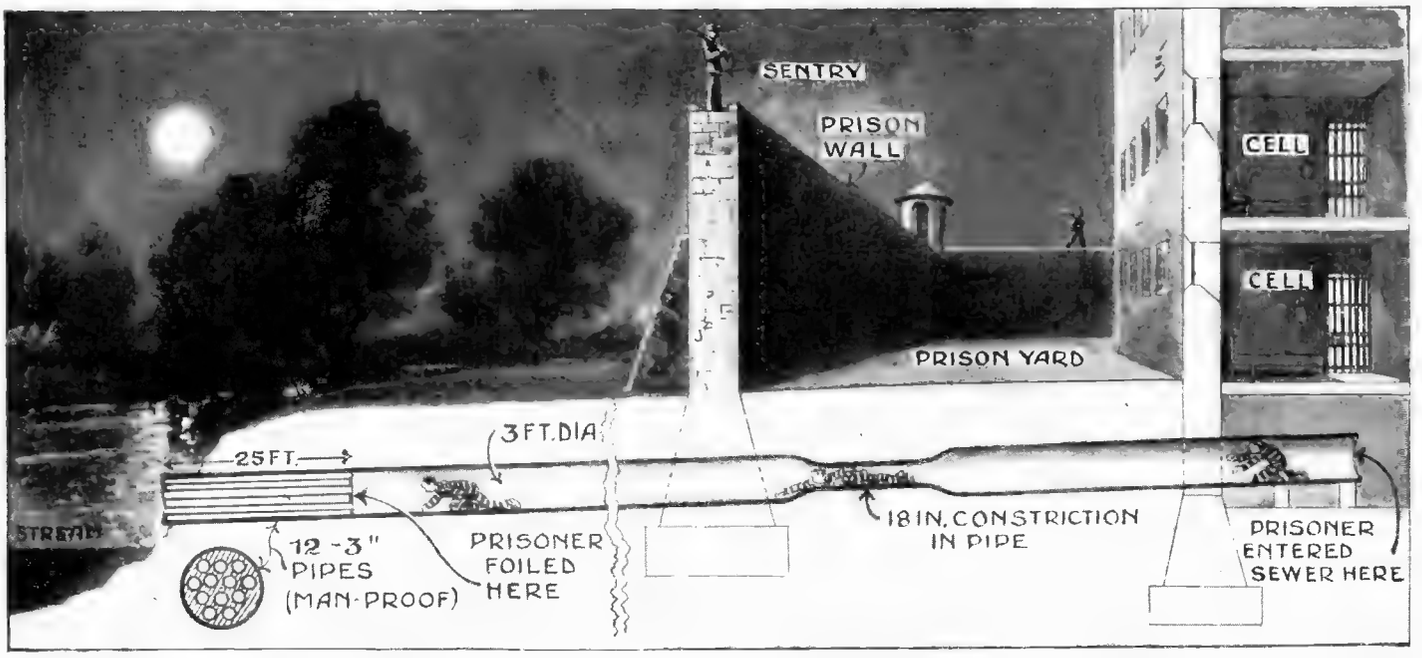
One of the methods that prisoners used for escaping from the Federal Penitentiary at Atlanta, Ga., is illustrated in detail herewith. This prisoner was kept in the tubercular tent colony in the prison yard and was allowed quite some freedom. He and his partner dug a tunnel from the center of his tent down under the wall surrounding the prison and up to the surface and escaped. The dirt from the tunnel was evenly distributed around their garden so as to avoid suspicion. Even a signal system and dirt car were used.

THE interior of every prison is a seething battle of wits between the convicts and their keepers. The prisoners are constantly scheming to outwit the officers and escape, and the officers are scheming with equal intensity to keep from being outwitted. In spite, however, of the utmost vigilance, a prisoner will now and then get away. He who said "There is nothing new under the sun" had never been in a penitentiary. Something "new" is always being "pulled off" by both officers and prisoners, and it is very often the ending of the last act before one can tell how a particular "play" is going to come out.

The prison conduit system may well be called the first aid to the convict, because when contemplating an escape the possibility of going out through the underground pipes is always carefully studied. Under every large prison is a veritable maze of piping of every description through which water and wires are carried to the institution and the sewage is taken away. When therefore a prisoner at the Federal Penitentiary at Leavenworth decided upon a getaway his first thought was of "doing a mole," as the prisoner calls burrowing out underground. He worked in the office of the prison superintendent of construction, so it was comparatively easy for him to steal a blueprint, which showed where one of the big disposal pipes was located in the new wing which was being built. Being constantly employed in carrying messages to the new wing he found it equally easy to drop below the temporary flooring into the cellar and begin his search for the pipe. He found it within a few moments, notwithstanding the fact that the officials had tried to conceal it by covering the end with dirt until such time as it was ready to be connected on the inside. The prisoner scraped the dirt away with a sharp piece of wood and crawled into the pipe head first.

It was easy enough at first, as the pipe had a diameter of about three feet. But suddenly a joint appeared and the conduit was reduced in size to a diameter of about eighteen inches. The prisoner gave a wry

(*Continued on page* 764)



At the Federal Penitentiary at Leavenworth, Kansas, a prisoner tried to escape by crawling through a sewer pipe, which in his opinion led to freedom. However, the end of the pipe was constricted by a series of 3-inch pipes and so escape was rendered impossible. Imagine the prisoner's consternation.

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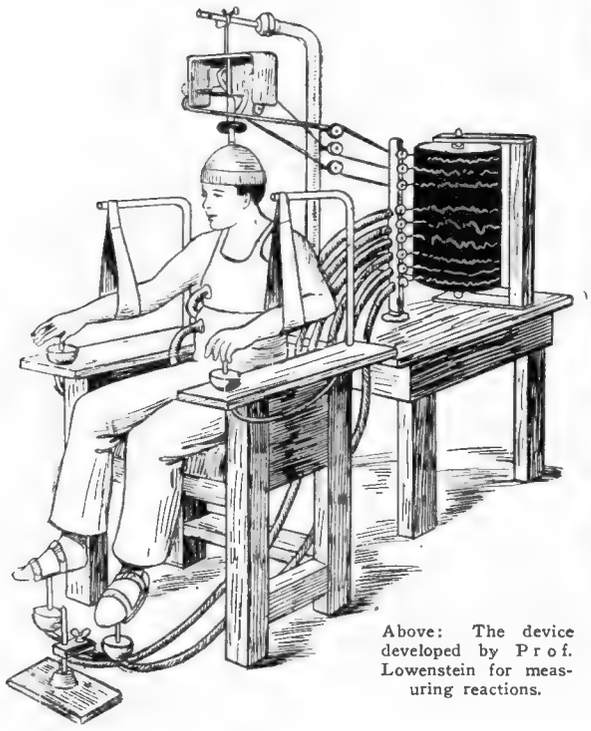
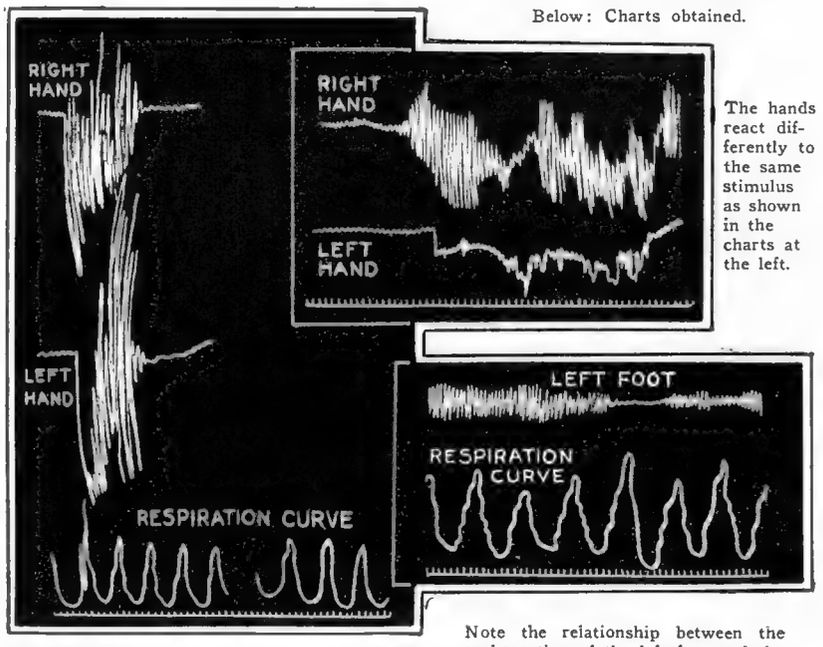


Above: The device developed by Prof. Lowenstein for measuring reactions.

Below: Charts obtained.



The hands react differently to the same stimulus as shown in the charts at the left.

Another chart showing the different hand-reactions and the respiration-curve.

Note the relationship between the soul-reaction of the left foot and the respiration-curve as shown in the diagram directly above.

New Light on Human Reactions

By DR. BUTTERSACK

THE whole world is united in the belief that the human body as well as the systems of animals and plants are seemingly sensitive reflex apparatus, that is to say, that they react to the smallest excitations in some way. In general, former experimenters were satisfied with the coarser manifestations and stopped at blushing, paleness, trembling, shuddering, chattering of the teeth, the fixed eyes of fright, the sweat of fear, the influence on the secretions of the body such as milk, etc. One could very well follow the links of these reflex chains into a region where they would show visibly the processes of the soul now invisible and unknown. The suspected murderer could be brought to the corpse of his victim and made to gaze at the remains, but that of course is a very crude and unreliable method.

Now, Tarchanoff as far back as 1890, carried peculiar electric currents through the skins so as to show potential variations under the influence of bodily and mental excitation, and George Sticker in 1897 showed by using this same exciting current how words, pictures, smells, musical notes and the like, which with other currents gave no reaction, with this one would give a strong reaction, or "beat," under the incitement of this or that excitation which would "go to the heart." This too would happen when the essential word was spoken with perfect equanimity along with other indifferent words.

Unfortunately, these observations have been forgotten in the depths of the past, but we will be reminded of them by parallel observations from Brunzlow in Muenster and Loewenstein in Bonn. They not only reveal the electric actions in the skin, but the most delicate changes in the muscular system; these have a definite interlaced system of their own and develop changes in potential through the entire mass starting from the smallest area. The above named investigators express themselves thus: Every excitement of the soul is accompanied by changes of the innervation (or nerve action) affecting the muscles. If such changes are observed, then the excitation of the soul is revealed quite independently, as to whether the subject under examination knew about it or even wishes to deny it.

An apparatus which appears more complicated than its theory would indicate, inscribes upon a revolving drum the curve of hand, feet, head, chest and abdominal regions. If the subject is acted upon by any excitation such as shock or the prick of a needle, then the movement of the subject gives a characteristic change in the curve which curve-change is visible to the naked eye. But not only do bodily excitations operate thus; those of the soul have the same effect. The simple mention of a name, the bare announcement of the explosion or of the needle prick before either has occurred is enough to change the normal curve. These reactions are so delicate and act so completely without the knowledge or control of the patient that it is impossible by the greatest exertion of the will for him to overcome them. It is as impossible to suppress them as to prevent the shrinkage of the pupils of the eyes in strong light or to overcome the knee reflex phenomenon.

The amplitude of the curve naturally depends upon the susceptibility to excitement of the particular nerve band, but whether great or small, the change in the curve is always to be seen. It follows from this that the excitement reaches the very soul and is woven into its everlastingly moving fabric. If it does not do this then the soul is unaffected, and the curves of the potential of the muscles go along without being affected.

But these investigations are by no means so very simple. The physician and psychologist must find out the psychic excitations to which the specific curves under investigation correspond. This has its characteristic difficulties in such physically unbalanced subjects, who for any motive are profane in their sickness. The best known in this regard are the so-called hysterical subjects and the shell-shock subjects related to the first. The Loewenstein method has detected at once such subjects who would claim to be deaf to a pretended shell explosion. On the one side it excites grave doubts that soldiers with injuries to the ears of unequal severity, but actually existing, were not at all or only temporarily made hard of hearing and such observations occasioned doubts as to the propounded or suggested causes of the trouble. On the other hand, the infirmities due to such changes in the hearing process lead to no conclusion as reliable as the above to enable us to say that the simulation existed or that imagination was acting.

But at last the medical profession has a relatively simple method to determine quite objectively whether the subject hears or does not hear. It even enables the degree of the affected hearing to be estimated. Not only can the presumably deaf be made to hear, but the presumably blind can be made to see. The man without sensation of touch can be made to feel and the same for those who think they have something the matter with their bodily system, because everything is present in the soul. It is simple to see how rich in results this method is: it frees not only the public from the great expenditures for all kinds of pensions, but it returns to the community those really capable of work.

Freud psycho-analysis stands side by side with this physiological method. The two will give, in the course of time, many surprising insights into the intricacies of the life of the soul.

"Life After Death"

Prof. Charles Henry of Paris, France, recently issued a statement to the effect that he has proof, backed by mathematics, that "nobody dies entirely." He said in part . . . "that little something which gives you a distinctive personality among the millions of your fellow beings is immortal. You hand your soul on to others, that's all." This decision is based upon calculations which have yet defied all attempts toward accurate solution.

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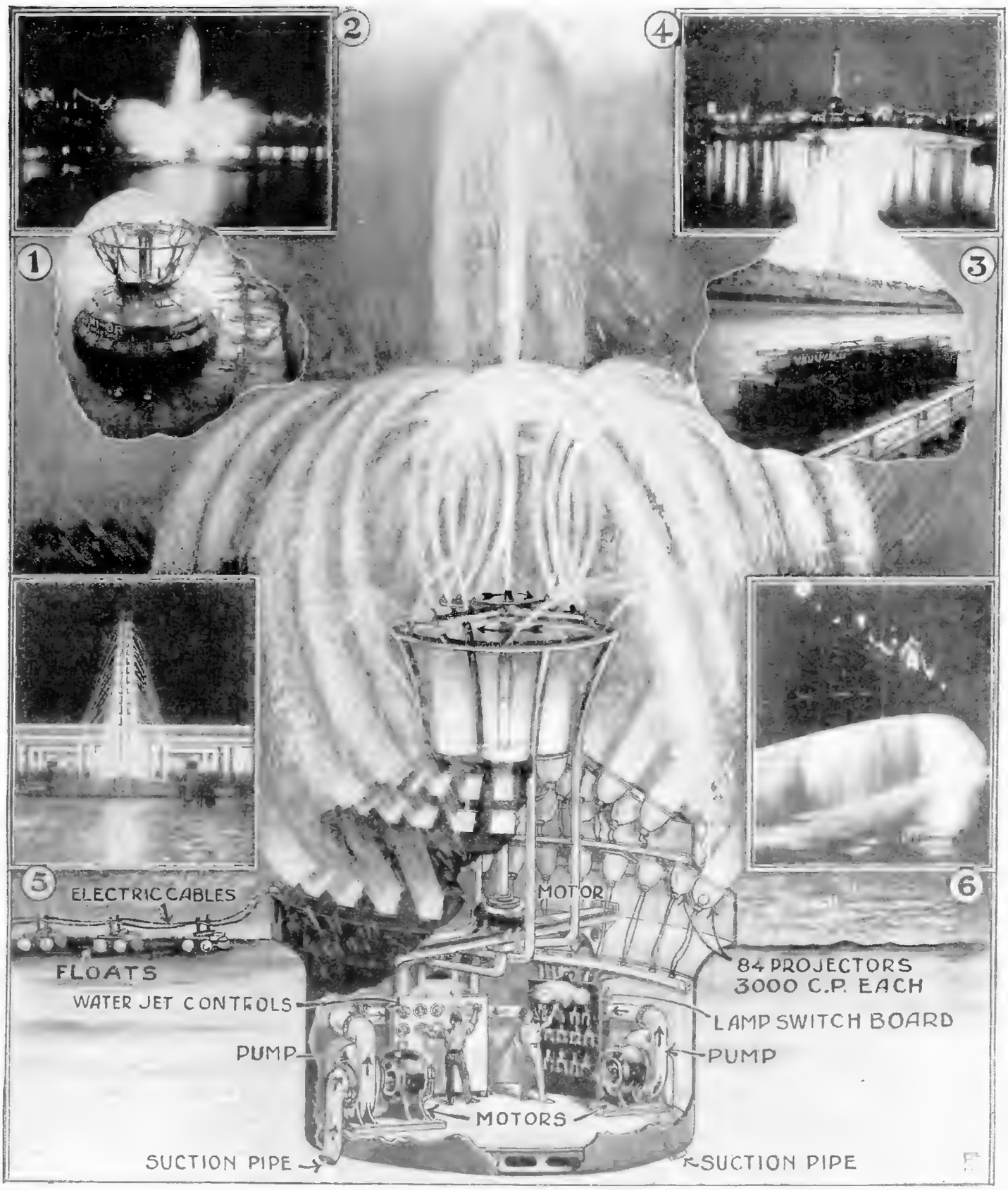
Electric Fountains Float In the River Seine

By A. N. MIRZAOFF



THE photograph in Fig. 1 shows a floating fountain moored to the bank of the Seine during the daytime, while Fig. 2 shows the effect of the same when in action and illuminated by colored lights at night. Fig. 3 shows the Eiffel Tower and surrounding territory in daylight and Fig. 4, at night. Photos 5 and 6 show novel forms of illuminated fountains. The central part of this page depicts the actual construction of an electrically illuminated fountain that floats on the surface of a river. In use in Paris, the fountains can be transported from place to place as needed for display purposes. Note how some of the jets can be revolved while keeping up a continuous play of water. Colored lights complete the effect. The fountains are propelled by water jets.

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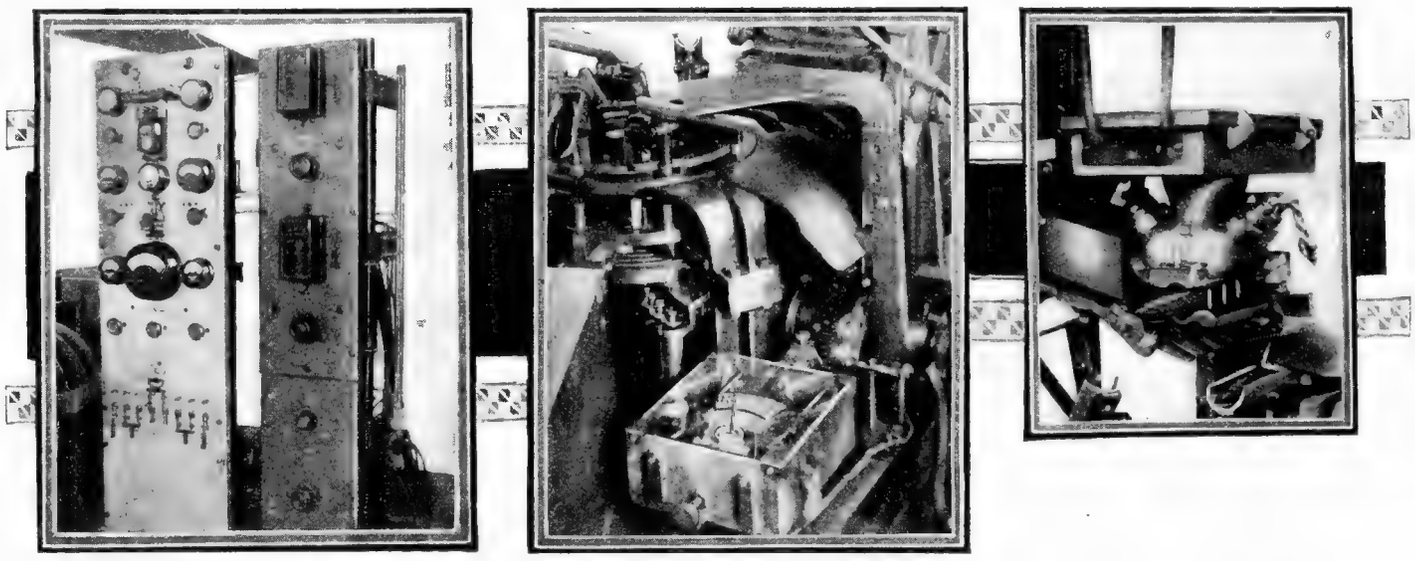
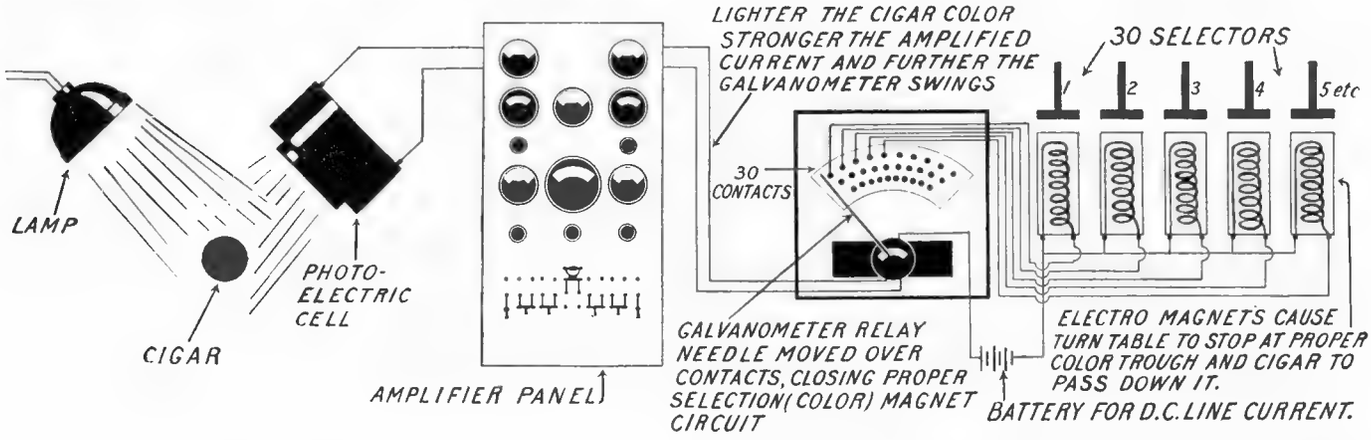
Photo-Electric Eye Sorts Cigars




LIGHTER THE CIGAR COLOR STRONGER THE AMPLIFIED CURRENT AND FURTHER THE GALVANOMETER SWINGS
30 SELECTORS
1
2
3
4
5 etc
30 CONTACTS
LAMP
PHOTO-ELECTRIC CELL
CIGAR
AMPLIFIER PANEL
GALVANOMETER RELAY NEEDLE MOVED OVER CONTACTS, CLOSING PROPER SELECTION (COLOR) MAGNET CIRCUIT
ELECTRO MAGNETS CAUSE TURN TABLE TO STOP AT PROPER COLOR TROUGH AND CIGAR TO PASS DOWN IT.
BATTERY FOR D.C. LINE CURRENT.

The three photographs at the top of this page show views of the automatic cigar sorting machinery which depends upon the action of a photo-electric cell for its operation. The diagram shows, in simplified form, the various instruments that make this form of sorting machine possible. Light is reflected from the cigar and acts upon the photo-electric cell to a greater or lesser extent, depending upon the color of the cigar. The photo-electric cell current is then amplified and actuates a combination galvanometer and relay. This instrument closes a circuit through one or another electro-magnet, depending on shade of cigar, which operates a selector that drops the cigar down into a trough of other cigars of the same color.

A REMARKABLE machine has been perfected after five years of experimenting, which will sort objects according to their color far more swiftly and unerringly than the most carefully trained human eye.

In its present form, this machine automatically separates cigars into 30 different groups depending on the shade of its wrapper. Imagine picking out 30 different shades of brown as represented in the familiar range of cigar colors from "claro" to "maduro"! That alone is a task almost impossible for human beings. But this machine does just that without the slightest hesitation or error, at the rate of over 60 cigars a minute, or 3,600 cigars per hour.

Exhibited at the recent tobacco exhibition in New York City it attracted a great deal of attention, and predictions were freely made that an adaption now being worked out by the designers would shortly make possible a real standardization of color values in hundreds of industries.

HOW THE MACHINE WORKS

As made for the sorting of cigars this machine consists of a finger which picks up each individual cigar, a photo-electric *eye* which measures the color, an amplifying panel which boosts the infinitesimal current generated in the eye, a switching galvanometer which actuates the mechanical sorting mechanism, and a set of 30 compartments arranged around a common center, into which the cigars are accurately distributed by the sorter.

In detail the operation is this: The cigars are fed, either by hand or from a conveyor belt, into a hopper slightly wider than the length of the cigars, and mounted above and to one side of the photo-electric cell. From the bottom of this hopper an ingenious split finger picks out the cigars one by one with meticulous care and carries each to the bottom of the *eye*.

The *eye* is a vacuum tube similar in shape to a small X-ray tube, with two terminals connected to a battery. One terminal is enlarged within the tube and heavily coated with potassium. The entire tube is covered by a light-proof case and in the darkness no current flows between the two terminals. Light, however, activates the potassium-covered terminal, causing an emission of electrons, which emission constitutes a current flow. In a few words, therefore, this *eye* is simply an electric switch, opened and shut by light and darkness.

Below the *eye* is another chamber containing four small electric light bulbs, shielded from the tube above. When the finger places the cigar in position within the lighted chamber, a shutter opens a slit in the covered tube-chamber above it, and only the light which is reflected from the wrapper of the cigar is permitted to act upon the tube.

Obviously, the darker the color of the cigar, the less light will be reflected upon the tube, and *vice versa*. The actual color of the cigar, then, determines the amount of current permitted to flow between the two terminals of the tube. And since every color reflects a different amount of light, it is readily seen that the only limit to the color-sorting abilities of this machine lies in the minuteness with which these varying amounts of current sent through the tube can be individualized and caused to operate mechanical sorting apparatus.

The current actually flowing in the tube circuit is, of course, so small that it cannot be depended upon to actuate any mechanism. It is, therefore, sent to an amplifying panel placed near the machine, where the same type of vacuum tube apparatus used in trans-continental telephony is used to boost the current to usable proportions.

From the amplifying panel the electric current, still so small that it will not make a tiny motor work, in spite of this boosting, is led to an extremely sensitive switching

(*Continued on page* 763)

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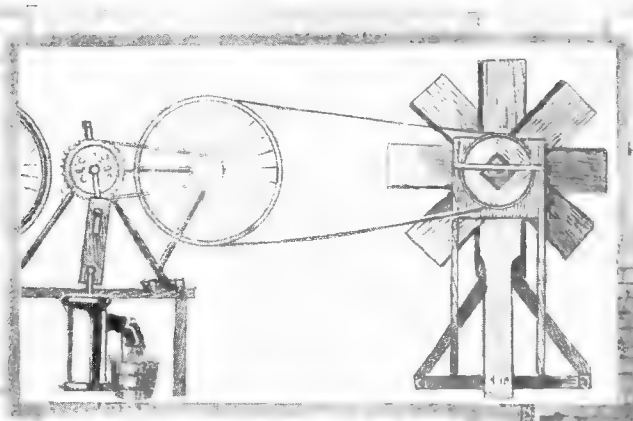
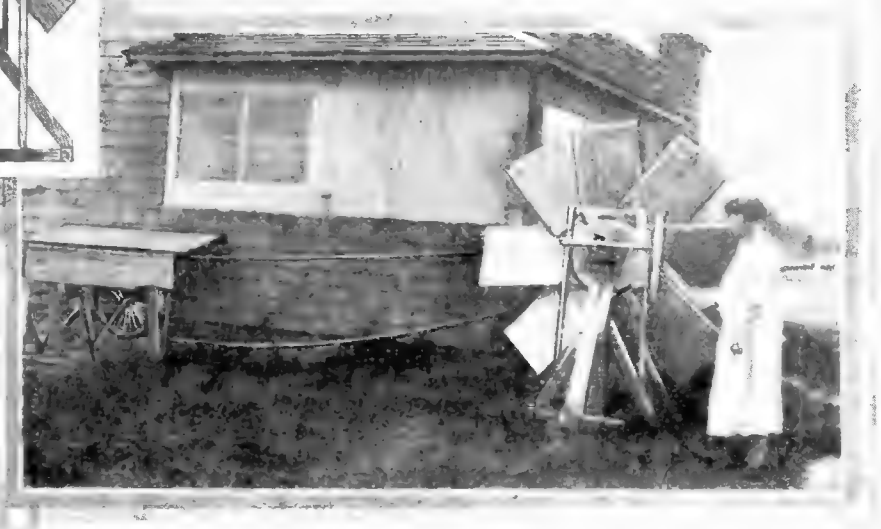
New Labor Saving Devices





An ingenious mechanic of Brewster, Mass., has succeeded in harnessing wind power to pump water for his country home. He made up a very simple wind mill that is shown in the photograph and drawing above, and hitched to the mechanism of a bicycle by means of a belt. The crank of the latter actuates a pump and it is said that 20 minutes' work by this device will pump enough water to last for two weeks. In a high wind, a buzz saw can be operated by the wind mill.

From New Jersey we receive word of a novel grass cutting device invented by two young boys. They attached their bicycle to a lawn mower as shown in the photograph at the left and now combine pleasure with work. By pedaling the bicycle around the lawn, the grass is neatly clipped.

New Fruits

The three photographs directly above illustrate a relative of the cucumber and squash family which has been imported into this country from Mexico and Central America. Grown in Florida, it is an enormous producer, single fruits weighing from 8 ounces to a pound.

The photo at the left shows an example of the Dasheen, a richly flavored fruit sometimes known as the Chinese Paro. A single cone often weighs nearly five pounds.

The "Monistera deliciosa" of Trinidad looks like an ear of corn but its taste resembles that of a combination of fruits, such as strawberries, pineapples and bananas. This new food takes 18 months to ripen after the plant blossoms and has been succesfully raised in southern California.

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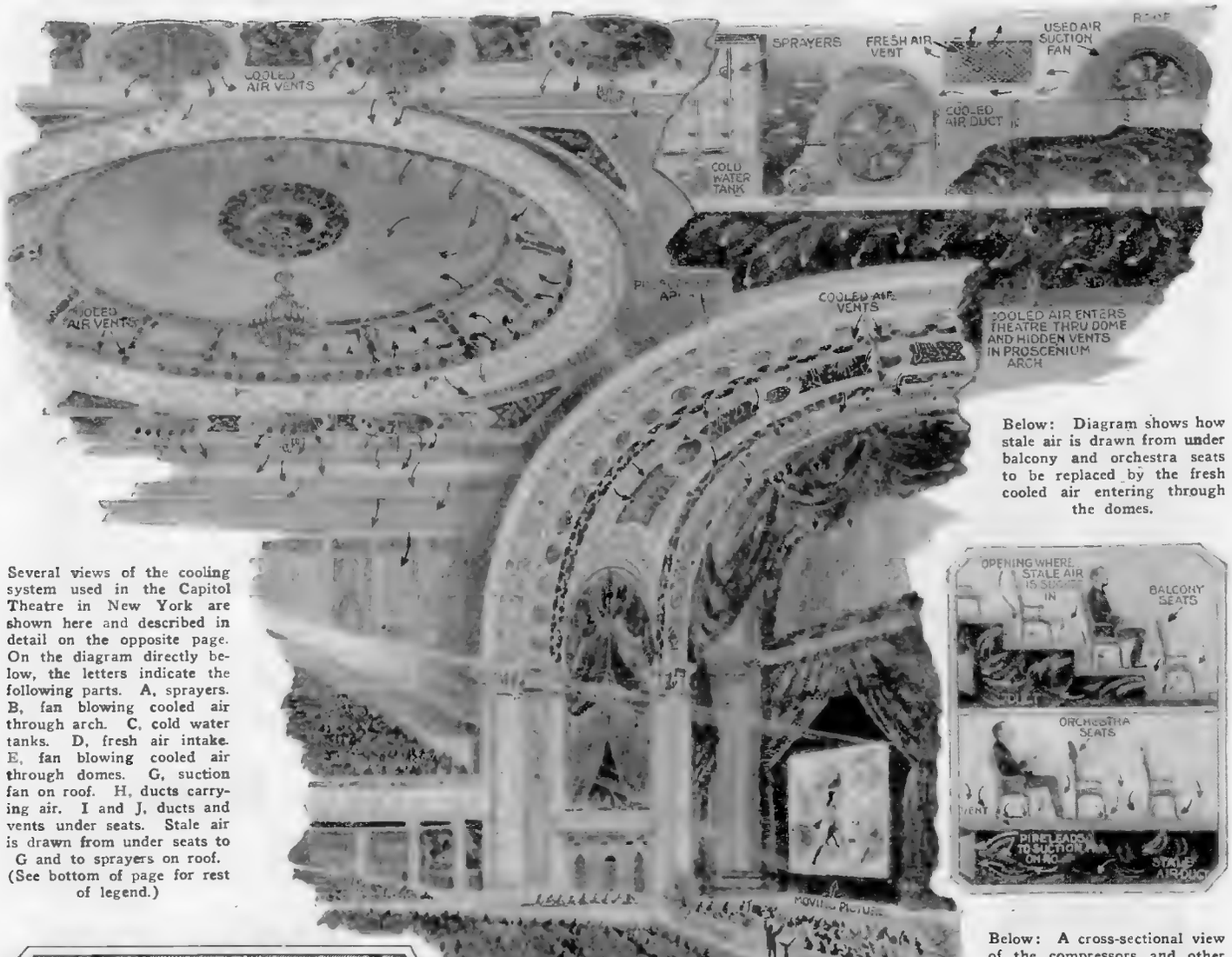
How New York Theatre's Air Is Cooled

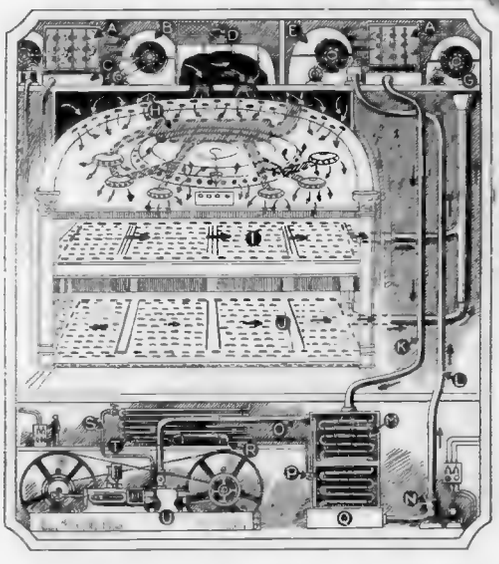
A Complete Cross-Sectional Diagram of the Efficient Cooling System Used in a Large Movie House.

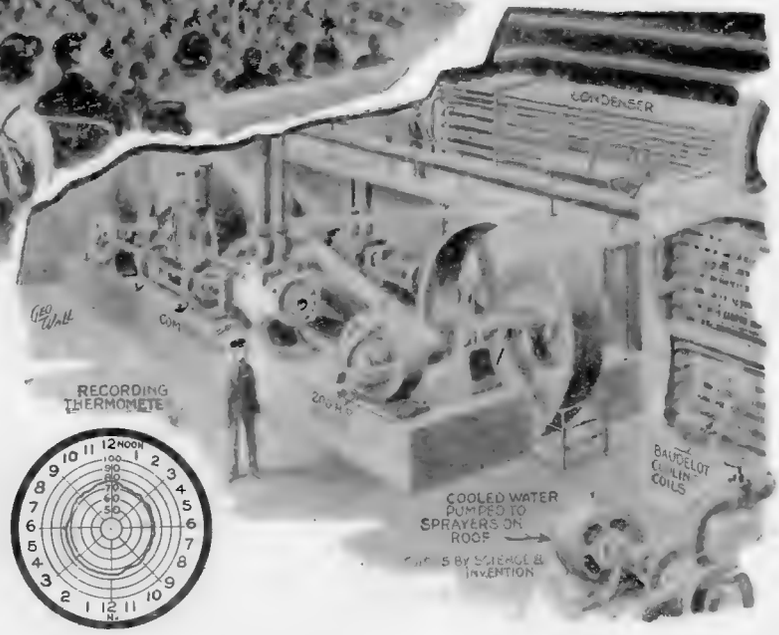


Below: Diagram shows how stale air is drawn from under balcony and orchestra seats to be replaced by the fresh cooled air entering through the domes.

Several views of the cooling system used in the Capitol Theatre in New York are shown here and described in detail on the opposite page. On the diagram directly below, the letters indicate the following parts. A, sprayers. B, fan blowing cooled air through arch. C, cold water tanks. D, fresh air intake. E, fan blowing cooled air through domes. G, suction fan on roof. H, ducts carrying air. I and J, ducts and vents under seats. Stale air is drawn from under seats to G and to sprayers on roof. (See bottom of page for rest of legend.)

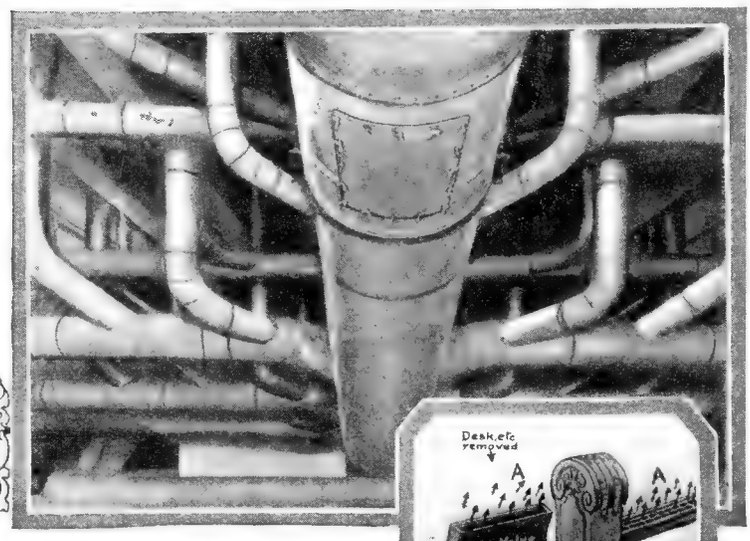
Below: A cross-sectional view of the compressors and other parts of the cooling system located in the basement of the theatre.

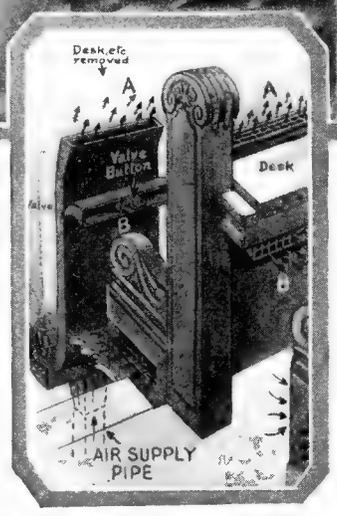




K, water returned by gravity from spray chamber and recooled. L, cooled water pumped to sprayers on roof. M, cooling coils. N, pump. O, carbon dioxide suction line to compressor. P, expansion valve. Q, cold water tank. R, carbon dioxide high pressure liquid receiver. S, discharge line to condenser for high pressure carbon dioxide. found on the opposite page. Typical daily temperature chart appears at right.

In the London County Council Hall, in England, each individual member can control the condition of the air at his own particular desk, regardless of the desires of others. The photographs and diagram herewith show how this is accomplished.





The maze of distributing pipes under the Council Hall may be seen in the photograph above. By pressing the valve button indicated in the diagram at the right, the occupant of the seat can direct the flow of air toward his body or upward, as may be desired. The upper left-hand photo shows this being done, and the one at the right gives a more general idea of the incoming and outgoing air ducts. The air used is heated and humidified in winter and cooled and dehumidified in summer. The average humidity and temperature are automatically controlled.

Refrigerated Theaters

By H. WINFIELD SECOR

THE writer remembers about fifteen years ago of walking down a Philadelphia street and noting with surprise and interest a large placard placed in front of a new motion picture theatre and bearing the legend, "twenty degrees cooler than the street." It sounded like hokum, and it must be admitted that upon visiting the theatre the management had endeavored to carry out his proclamation with a goodly number of electric fans placed all along the side walls and in the rear of the theatre. But the twenty degrees cooler than the street never materialized to an engineer's way of thinking, although the general public may have kidded themselves into believing that such a reduction in temperature was being effected.

Now, however, there is at least one theatre in New York City which can produce an auditorium temperature of twenty degrees cooler than the street, and more if desired. This is the famous Capitol Theatre, the world's largest motion picture house, and very elaborate and newly designed ventilating dehumidifying and cooling machinery has been installed in this beautiful theatre to not only provide a constantly changing air content in the auditorium of the theatre, but a cool air from which excess moisture has been removed. It is not sufficient to simply cool the air and blow it out in the auditorium as some theatres have attempted to do in the past, by blowing a draught of air over ice or by employing similar means; the air must have the humidity at the proper point, and one of the greatest problems in any undertaking such as this, is to properly inject the air into the auditorium and remove the vitiated air without causing any draught whatever which will be noticeable to those in the audience.

As the accompanying wash drawing by our able artist, Mr. George Wall, who inspected the whole lay-out personally for this purpose, clearly demonstrates, the cooled and revitalized air is blown down into the auditorium through a series of openings in the arched ceiling of the auditorium, and also through openings placed around the proscenium or stage arch.

In this way the air circulates through the theatre in ever expanding air currents or whirls, with the consequence that the expansion and circulation of the air currents is so well distributed that no draught or semblance of a draught is noticeable to the audience. The vitiated air is sucked out from the auditorium through registers placed under the seats and other appropriate places. As the illustration on the opposite page shows, a huge cooling plant is installed in the basement of the theatre, and this utilizes electric motor-driven compressors which compress carbon dioxide gas in order to liquefy it and create cold in the pipe coils, over which the water used for dehumidifying and washing the air circulates, and in turn becomes cool. The two carbon dioxide compressors have a combined refrigerating capacity of 400 tons, and represent a form of cooling plant which is new in this country, but which has been extensively employed in Europe and on board ships. Each of the carbon dioxide gas compressors are driven by a 200 horse-power electric motor of the variable speed type. The compressors are charged as required with carbon dioxide gas from tanks resembling those used in charging soda fountains. Under the extreme pressure created by the huge pistons moving back and forth in the cylinders of the compressors, the gas is liquefied.

Next we come to the Baudelot cooler through which the water from the roof circulates over 12,000 feet of pipe coils, and the frigid expanding gas here opens its attack on the heated water, causing it to be greatly lowered in temperature as it leaves the pipe coil chamber. The cooled water then goes into a centrifugal motor-driven pump, and is repumped to the roof, where it passes into the spray jets inside one of the air chambers, and starts in its work of dehumidifying and washing the passing currents of air as they are drawn past the spray jets, by the powerful blower fans shown in the picture on the opposite page. The circulating system delivers 1,000 gallons of water per minute to the cooler in the basement, and its temperature is reduced to forty degrees Fahrenheit, after it has passed over the cooling coils.

The cooled water is pumped to the roof through insulated ducts, where as aforementioned the chilled water is spread through special jets which discharge it as a curtain of heavy mist. Going back to the roof once more, we find that a number of powerful ventilating fans have been put into action, in order to draw 150,000 cubic feet of air per minute through the curtain of cooled water. This air, thus brought to a proper temperature, is sufficiently cooled and freed from humidity as to be fit for blowing into the theatre auditorium.

It should be mentioned in passing that the stale air from the auditorium is drawn out through registers under the seats and under the floor by means of special suction pumps, and this air is returned to the roof air reconditioning plant, or exhausted into the atmosphere, as may be desired. Every six to seven minutes during summer afternoons and evenings a complete change of air is thus brought about in this theatre. This complete change of air helps to bring about a more healthy condition for everyone in the audi-

(*Continued on page* 752)

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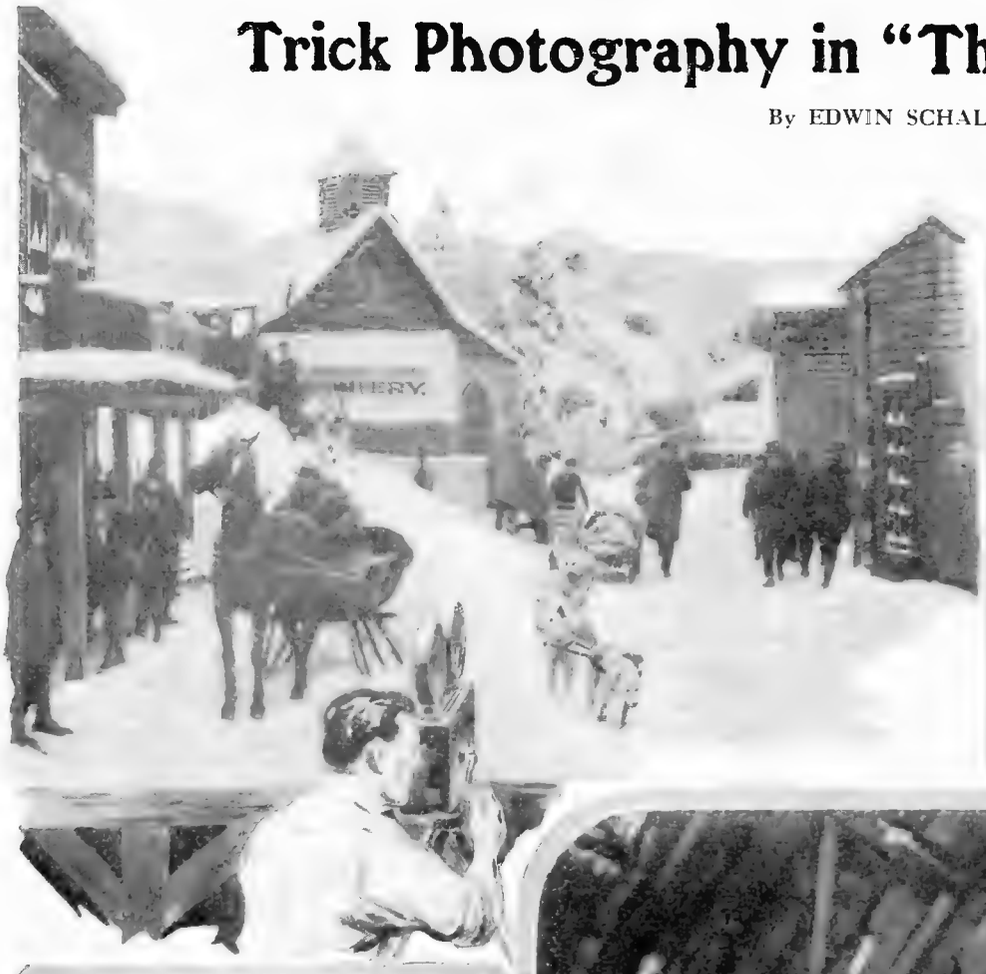
Trick Photography in "The Gold Rush"

By EDWIN SCHALLERT



One of the main scenes in Charlie Chaplin's latest comedy was the main street of a small mining town in Alaska. Realistic though the scene appeared, it was all photographed entirely within the studio. This is clearly shown in the illustration directly at the left. The horse and dogs were driven up on the stage from the wings and off to the left and right, respectively, out of the field of the camera. In viewing the picture, it was almost impossible to detect the fact that the mountainous country visible in the background was in reality only property scenery. In fact, practically the entire picture was taken within the four walls of the studio, and thus the necessity of waiting for favorable weather was eliminated.

In the scenes where a small log cabin was blown across the country by a terrific wind storm and finally lodged on the edge of a precipice, various clever mechanical arrangements were resorted to in order to produce the required effect. Several views showing the interior of the cabin through the windows of which the landscape could be seen flying past were taken in the manner shown at the right. The hinged cabin walls were rocked by stage assistance and a cyclorama run past back of the cabin gave the effect of motion. The cyclorama is nothing more or less than a wide sheet of canvas arranged on rollers and upon which various scenes are painted. Revolving the rollers causes the scenes to be unfolded in front of the camera. When the cabin was perched on the precipice, it slipped several times. This effect was produced by jolting the cabin as it hung on cables as above.

Many of the most laughable moments in "The Gold Rush" were afforded by scenes taken inside of the cabin while it was resting insecurely on the edge of the cliff. The floor was tilted at a sharp angle and Charlie and his pal were having all kinds of trouble trying to save themselves from falling out over the cliff. The photograph directly above shows their predicament. Several times one or the other of them started to climb up the floor, slip and slid part way out of the open door below which there were supposedly hundreds of feet of space. The problem of getting out was finally solved by Charlie's pal climbing up Chaplin's body and reaching the doorsill on the opposite side of the cabin, thus pulling himself out and rescuing Charlie with a rope. At the moment of rescue, the cabin slides from its precarious position and crashes to the foot of the cliff.

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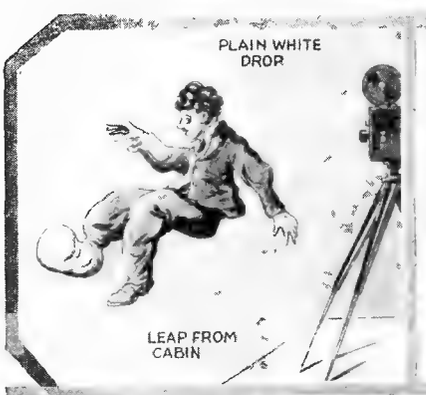
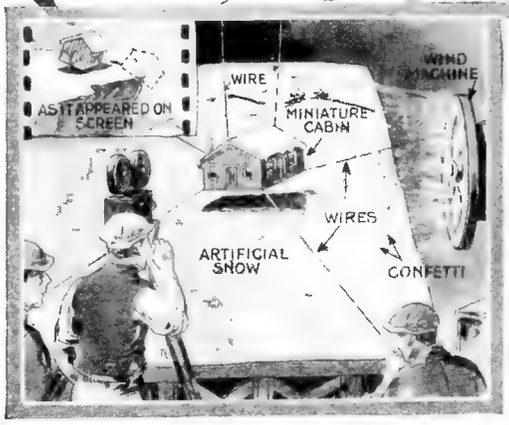


The scene of Charlie jumping from the cabin just as it slipped and fell was accomplished by double printing. One scene was taken of the miniature cabin on the cliff and another of Charlie jumping in front of a plain white curtain, as at left. Finished picture appeared as at right.

Charlie, not knowing that the cabin was perched on the edge of a cliff, forced the door open and found himself swinging in space. The exterior pictures showing this were taken with a miniature cabin and a mechanical figure operated by wires, as shown directly above. During part of the picture, Charlie's partner was half crazed with hunger and, to his vision, Charlie apparently turned into a huge chicken. This was produced by means of the fade-out iris on the camera being carefully manipulated so as to blend one figure into the other.



Exterior shots of the cabin being blown by the wind were taken in miniature as above.

CHARLIE CHAPLIN'S latest film success, entitled *The Gold Rush*, was a most interesting picture from all viewpoints. It contained comedy, human interest, pathos and enough trick photography to make it unusual. In briefly told form, the picture ran as follows:

Charlie, with his inevitable derby, cane and enormous shoes, was prospecting for gold in the Chilcoot Pass region of Alaska. He and his partner, an old-time prospector, are caught in a severe storm that lasts for days. They take refuge in a lonely cabin and finally their food supply is exhausted. They endure all manner of hardships, due to hunger, and finally cook and eat one of the comedian's famous shoes. The shoe itself is served on a large platter and the laces take the form of a side dish of spaghetti.

The old-timer's reason finally gives way temporarily, due to hunger, and his imagination causes him to see Charlie gradually take the form of a huge chicken. Under the comedian's care, however, he soon recovers. Finally the storm abates and Charlie and the prospector part company. The latter continues his prospecting and finally locates an enormously rich mine. Here he has a battle with another prospector who tries to claim the location. Chaplin's former partner is injured and becomes crazed. He wanders aimlessly about, having totally forgotten the location of the mine, and finally drifts into the mining town in which Chaplin is staying, acting as a caretaker for the cabin of another prospector who is out in the hills.

Charlie, in the meanwhile, has adventures of his own, not the least of them being that of falling in love with one of the dancehall girls. Finally he and the old prospector meet and the latter, still unable to remember the exact location of his mine, knows that if he can find the cabin in which he and Charlie stayed, he can find the mine by the bearings so obtained. He, therefore, rushes Charlie away and, arriving at the cabin, they spend the night, after having imbibed rather freely of a canteen of liquor. They fall soundly asleep and, during the night, a terrific storm carries their cabin away and lands it on the edge of a cliff, it being held there by the providential catching of a rope attached to the cabin on a projecting rock. Awaking in the morning, unaware of their plight, the two men attribute the unsteadiness of the cabin and the way in which it rocks to the over-indulgence in liquor the night before. Soon Chaplin tries to open one of the doors and, after throwing his whole weight against it, it suddenly opens and he finds himself clinging to the doorknob with nothing but empty space beneath. After a struggle he regains the interior. The cabin then shifts so that its floor is at a precarious angle and, after some scrambling, Charlie's partner finally gets out of the door on the opposite side of the cabin. He tosses a rope to the comedian and gets him out, the last part of the rescue being performed by a huge jump on Charlie's part. This was necessary, because at this moment the rope holding the cabin gave way and the house crashed over the cliff. They find themselves on the location of the lost mine and so become rich and sail back to the United States. On the boat, Charlie meets his old love and they live happily ever afterward.

The way in which most of the effects shown in this picture were produced are outlined on this and the preceding page. All of the interior views of the cabin were taken with a full-sized reproduction arranged in various ways as shown.

This model of the cabin was used in the studio for all of the "shots." Artificial snow was blown through cracks in the doors to lend reality to the picture. This gave the impression of a storm raging outside.

The jostling effects produced at the cliff's edge were given by raising and lowering the cabin quickly on a set of cables. The swaying of the cabin in the storm was produced with the cabin placed on a rotatable mounting. The walls and roof of the cabin were hinged so that they could be swayed. The changing of Chaplin into a chicken and *vice versa* was accomplished by a very cleverly manipulated fade-out iris. It is interesting to note that Chaplin also played the part of the chicken, encased in the huge disguise shaped as shown above.

To What Uses Can You Put Old Celluloid Sheets?

SCIENCE AND INVENTION wants to know what kind of useful articles can be made out of old photographic films or other sheets of celluloid. In order to present the best uses for this material to our readers, we are offering $100.00 in prizes for suggestions for the best uses of old films. Dig out some of your old camera films that did not turn out as well as they might and see if you can make something out of them that will be useful, interesting and novel. Note the large number of worth-while prizes that we are offering and follow the contest rules carefully.

$100.00 IN PRIZES

First Prize	$25.00
Second Prize	15.00
Third Prize	10.00
Four Prizes of $5.00 each	20.00
Six Prizes of $3.00 each	18.00
Six Prizes of $2.00 each	12.00
	$100.00

CONTEST CONDITIONS

1—The article must be made from old photographic films of any size or similar celluloid sheets.

2—The number of entries per contestant is not limited.

3—In event of ties the full amount of the prize tied for will be awarded to each tying contestant.

4—Films may be cemented, cut, steamed or pressed to form objects.

5—No prizes will be awarded for articles described on these pages.

6—A rough sketch and a description of fifty words or less per object are required. Models are not required but may be entered.
(CAUTION: Do not send inflammable celluloid articles through the mails).

7—Contest closes in New York on Wednesday, Dec. 30th at noon. All contributions must be in our hands at that time. Address entries to Editor, Old Film Contest, c/o SCIENCE & INVENTION, 53 Park Place, New York City.

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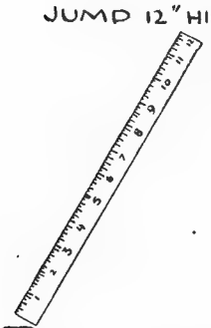
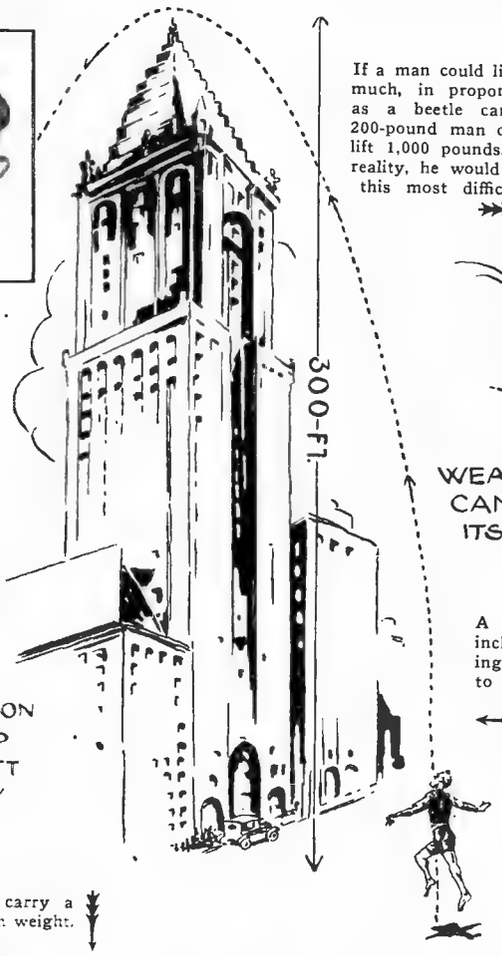
The Strength of Insects

By DR. ERNEST BADE

A FLEA CAN JUMP 12" HIGH



IF A MAN COULD JUMP IN PROPORTION HE WOULD LEAP OVER A 300 FT TOWER EASILY



If a man could lift as much, in proportion, as a beetle can, a 200-pound man could lift 1,000 pounds. In reality, he would find this most difficult.

WEAKEST BEETLE CAN LIFT 5 X ITS OWN WEIGHT

A 200 Lb. MAN WOULD FIND IT DIFFICULT TO LIFT 1000 Lb.

A flea can jump 12 inches high. If jumping were proportional to size, a man could jump 300 feet.

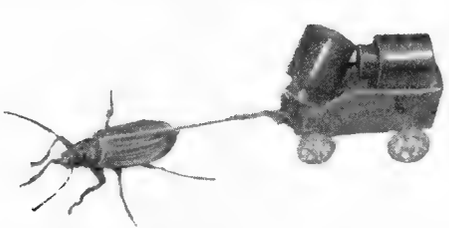
A Hercules beetle weighing only 1/5th of an ounce can carry a load on its back that weighs 5½ pounds. This figure was determined by the English entomologist, Weir, who has made many interesting experiments as to the strength of insects. Directly below a Calosoma beetle is shown hunting another species of beetle.

HERCULES BEETLE WGT. = 1/5 OZ.

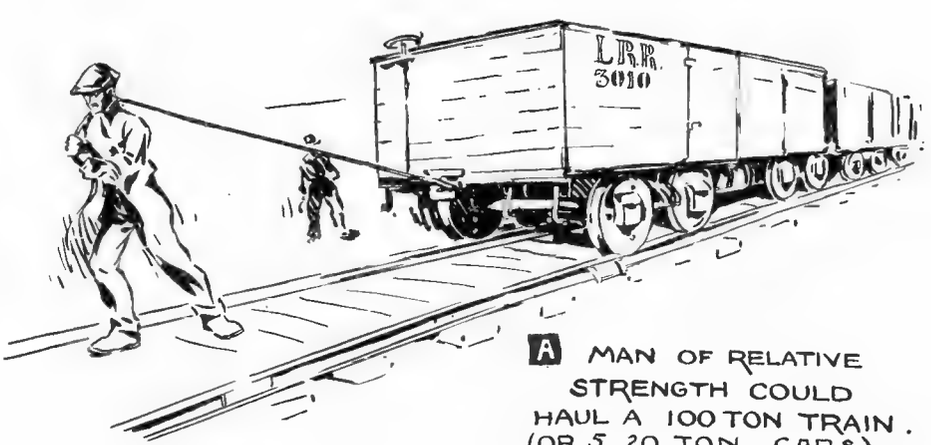
As below, a honey bee can carry a weight equal to 23 times its own weight.

THE HONEY BEE CAN CARRY 23 X ITS OWN WEIGHT

In the left-hand photograph directly above, a digger wasp is shown carrying a harvest fly. In the center photograph above a thread-waisted wasp is easily carrying a large caterpillar. As in the illustration directly below, if a man could pull as many times his own weight as an ant can, that man would be able to haul a 100-ton train.



The author conducted some interesting experiments with beetles. One was hitched to a small wagon weighing 11½ grams and this was easily pulled along by the beetle weighing ½ gram. Even 13 additional grams added made little difference. But when two 10-gram weights were added to the wagon, the beetle moved the vehicle in jerks.



A MAN OF RELATIVE STRENGTH COULD HAUL A 100 TON TRAIN. (OR 5 20 TON CARS)

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Astounding Strength of Insects

By DR. ERNEST BADE

THE director of all movements in the insect is the brain, the muscles being put in motion through the stimulation of the nerves. In this way the animal is enabled to perform those functions which we call life.

The muscles consist, primarily, of cross-grained muscle fibres, and these are responsible for the movements. They are attached directly to the inner part of the outer skeleton or they are joined to it with a tendon. The longitudinal muscles of the body are four in number, and two of these are dorsal and two are ventral to it. Every individual part of the body, the appendages, etc., as well as every part of the body has its own muscles, and the muscular strength of the insects, in comparison to their sizes, is far greater than the strength of warm blooded creatures.

Some peculiar and exceptionally interesting experiments have been carried out with various insects to test their strength, and, it was found, that an ant could pull a tiny wagon, to which it was hitched, up an incline. The wagon was 1,300 to 1,400 times as heavy as the ant, but still it was able to pull it along. This would be comparable to the strength of a man who could pull a railroad train of a 100 tons.

An English ornithologist, Weir, hitched a large stag beetle weighing 1.86 grams before a tiny toy wagon made of tin weighing 56 grams. The beetle pulled this load with ease. The experimenter then placed small pieces of lead in the wagon until the total load was 84 grams. This was pulled a distance of three centimeters but then the beetle was exhausted and refused to move. This animal therefore pulled 45 times its own weight. Other experiments led Weir to the conclusion that this insect, in comparison to its weight, was just as strong as a man who could lift 2,200 pounds with one hand. A hercules beetle (Dynastes tityrus) which Weir used in one of his experiments, weighed 6½ grams or about one-fifth of an ounce and this creature was able to carry a brick weighing 5½ pounds on its back.

Even the weakest of beetles are able to lift five times their own weight without undue exertion. A honey bee is able to move 23 times its own weight, while some can carry as much as 40 to 50 times their own weight. These experiments have shown, as they could be shown in no other way, the extraordinary muscular power of these tiny creatures.

Just consider the energy expended by a flea while jumping, then increase his size, and one arrives at the startling conclusion that if a man had the relative muscular power in his legs, he would be able to jump over the spire of a church towering 300 feet into the air, and he would be able to do this with ease.

Such strength stands the insects in good stead, for they are able to prey on their fellows and they often attack and destroy those which are much larger and stronger than themselves. Here in the insect world, as every where else, it is a battle for existence, and life is fought without regard to rules. The stronger falls a victim to the weaker through thousands of artifices and ingenious devices.

The obese caterpillar which sedately eats one leaf after the other, is frightened by a comparatively small thread-waisted wasp, its hereditary enemy. The wasp walks nervously about the leaf the caterpillar was eating, suddenly it hurls itself upon the caterpillar, grasps it tightly by the neck. Paralyzed by the sting, the caterpillar falls to the ground with the wasp. Then the paralyzed prey is carried by the wasp to a cavity and an egg deposited on it. Here the caterpillar serves as a source of food supply for the young larva of the wasp and is destroyed by it. But the caterpillar was carried by a creature much lighter than itself, an illustration of how nature utilizes the strength of insects. The digger wasp has such powerful wings that it can carry its prey through the air even though the victim be many times heavier than itself.

All these accounts of the prodigious strength of the insects, when compared, in size, to that of man, are extremely interesting. From a mechanical point of view these comparisons are by no means so extraordinary for they are based on false assumptions, a form of what has been called the conflict of squares and cubes, for volume decreases more rapidly in ratio than surface. The force that a muscle can exert depends upon its section or surface although its capacity for doing work depends upon its volume. It is for this reason that the insects are so powerful; increase their size and their strength is taken from them.

When comparing the muscles of man and insects, the latter will be 100 times shorter while at the same time it will be 1,000,000 times lighter, this is the third power, while the force that it can exert will be the square of 100 or 10,000 which is the second power. Therefore the muscle of the insect, supposed to be one hundredth of man's linear dimensions, furnishes, when it contracts, a force 10,000 times less than the human muscle exerted through a space which is only 100 times smaller.

Take the jump of the flea. Increase his size. Then the relative muscular power in his legs is such that, if it were a man, he could jump over a 300 foot steeple, which would be true if size only were considered. But the muscular contraction of the flea can raise it only twelve inches. Man can raise his own weight about five feet by leaping. For equal weight, the human muscle thus furnishes five times more work than the flea in a single jump.

Novel Sun-Clock

A novel sun dial which tells time by means of two hands located on a conventional clock face has recently been invented by Prof. W. E. Cooke, a Sidney, N. S. W., astronomer. The appearance of the device is shown in the photograph above.

THIS sun dial not only tells the time of day quite accurately, but also the day and month of the year. There is no clockwork mechanism to it, as the hands on the dial are geared to a revolving ring which is pierced with a tiny hole and fitted with a scale opposite that hole. The ring is revolved so that the beam of light admitted through the hole falls directly on the scale, and when in this position, the hands of the dial will indicate the exact time. The illuminated point on the scale shows the date. The pivots of the revolving ring must lie in a north and south line and the angle of the tilt of the ring must correspond to the latitude of the place where the clock is used. No calculations are necessary to determine the time. — *Ernest Brennecke, Jr.*

Polishing Shoes in Comfort

A shoe polishing device that folds up against the wall when not in use is illustrated above. When in use, the footrest can be locked rigidly at either of two heights. Under the footrest are two rollers upon which the polishing cloth moves back and forth, thus imparting a brilliant shine to the shoes. Space is provided for the polishing cloth and such accessories as cleaning liquid and paste.

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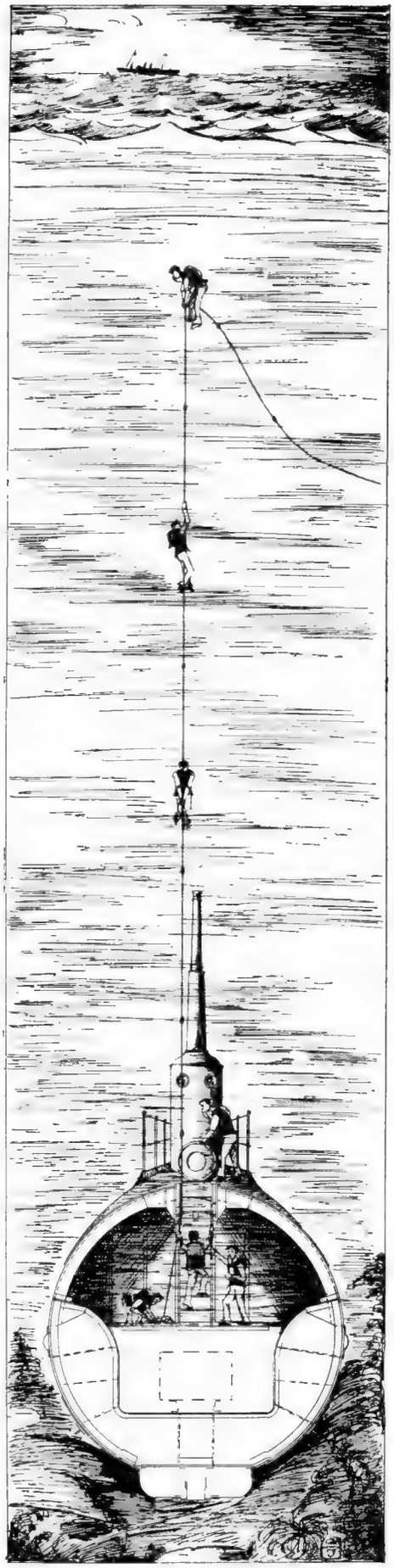


The above illustration shows the crew of a submarine leaving the disabled vessel by means of the life-saving suits and knotted rope mentioned in this article. By means of the rope, the men can ascend slowly and thus avoid the disastrous results of coming quickly to the surface of the water from great depths.

RESCUE METHODS FOR SUBMARINISTS

By F. W. HORTON

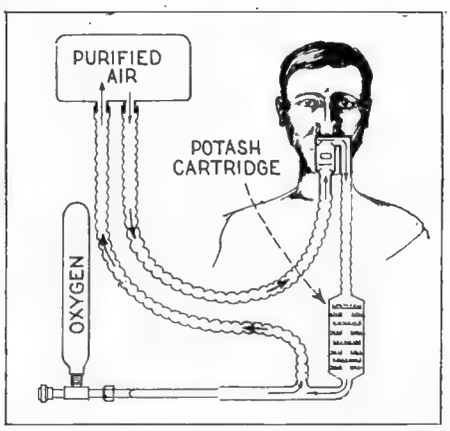
A Lesson From the Sinking of the S-51

United States Navy Far Behind in Rescue Apparatus for Sailors Trapped in Submarines. Read This Article Describing a Successful Apparatus of Foreign Design Which Enables Imprisoned Submarinists to Rise to the Surface. New and Untried? No! Was Used During World War!

ON the night of Sept. 25th, the U. S. Submarine "S-51" was sunk in collision with the "City of Rome" off Block Island. Only three of the crew who were able to gain the deck before the boat sank, were saved. Thirty-three men were drowned. For nearly a week the attention of the nation was focussed on the heroic work of the divers who attempted to raise the sunken boat in the hope, which later proved vain, that some of the men might have succeeded in shutting themselves in one or more of the water-tight compartments of the submarine that were not smashed by the collision.

This last disaster, following the many accidents to our Navy submarines during the past few years, notably, the sinking of the S-48 off Bridgeport, Conn., in December, 1921, the S-5 off the Delaware Capes in September, 1920, the G-1 at League Island, and the F-4 in Hawaiian waters, emphasizes afresh the many dangers inherent in the operation of submarines and leads to the natural question: Is there not some means of self-rescue that can be used by submarinists in the same way that parachutes are used by aviators or life preservers by the ocean traveler? The answer is "Yes." German submarines and those of several other European navies have been equipped for many years with individual rescue apparatus for every member of their crews. That the device is effective was demonstrated over ten years ago when the German submarine U-18 was sunk in the North Sea in June, 1915. The loss of the entire crew was reported to the British Admiralty, but within 10 days many of the men were safely back in Germany. Since this first rescue the device has proved its entire practicability by saving scores of lives. The accompanying illustration shows how the men escaped from the wrecked submarine with the aid of their individual life-saving apparatus.

The self-rescue suits fold into a very small space and weigh only 13 pounds.



This simplified diagram shows the action that takes place in the breathing apparatus of the under-water rescue suit. See text for full explanation.

A sailor wearing the rescue suit consisting of swimming vest and self-contained breathing apparatus.

The rescue device itself consists of a very buoyant swimming vest combined with an oxygen supply apparatus, which automatically regenerates an air supply sufficient for a half-hour's stay under water, if the wearer is working actively and for an hour's stay if he is not working. The whole apparatus weighs only 13 pounds and can be folded into a small parcel. It can be put on as quickly as a coat and does not hinder motion in any way. A clip prevents water entering the nose and breathing is done through the mouth. The exhaled air flows through the potash cartridge which absorbs the carbon dioxide given off by the lungs. The air is now breathable again and collects in the breathing bag after having been previously revivified with a fixed amount of oxygen automatically supplied from the oxygen cylinder. From the breathing bag the regenerated air is reinhaled. An auxiliary valve enables the wearer to pass supplementary oxygen directly from the oxygen cylinder into the breathing bag, if he is very active and is consuming more oxygen than is furnished automatically.

A small cylinder containing compressed air is used to fill the breathing bag in case there is not sufficient time to fill it with outside air when the apparatus is put on. This com-

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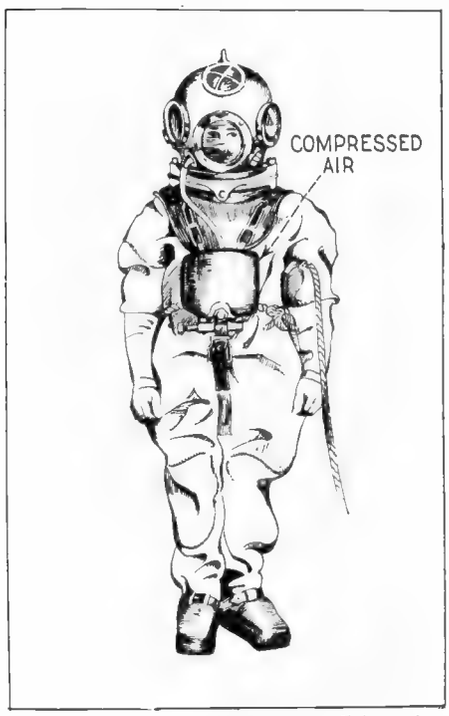
pressed air supply is also used to dilute the contents of the breathing bag, *i.e.*, lessen its percentage of oxygen, when at depths of more than 60 feet.

There is a safety valve on the feed pipe of the breathing bag which allows air to escape automatically in case the bag gets too full, thus preventing a disagreeable pressure on the lungs. This valve can also be



A front view of a modern European diving suit. It has no cumbersome air-hose, the air supply being regenerated by apparatus worn on the back. The life line carries a telephone cable.

operated by hand. Diving goggles to protect the eyes may be worn with the device.

In case a damaged submarine is lying at a depth of 50 feet or less it is safe for the crew to float to the surface at once, but at greater depths the ascent should be made slowly, the men holding themselves down by means of a knotted rope tied to the boat, and stopping at intervals which should be prolonged on nearing the surface. This slow ascent is of course necessary to prevent the "bends," the illness so much dreaded by the diver, which is caused by the formation of bubbles in the blood on the too rapid release from heavy pressure.

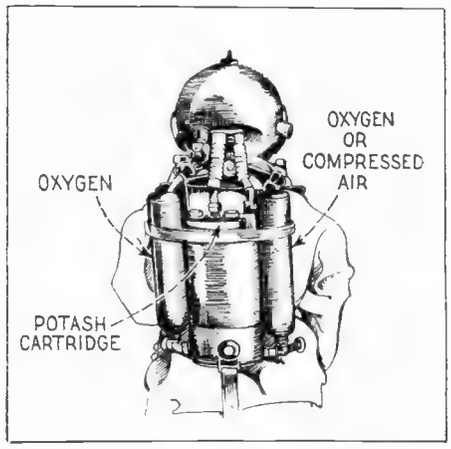
Every member of a submarine crew should be as thoroughly acquainted with diving tables as regular divers. These tables give the rates for hoisting the diver from any depth after various periods of submersion. They are illustrated by the accompanying chart which shows the procedure to be followed in ascending from a depth of 200 feet after being down a half-hour and after a two-hour's stay, at a depth of 100 feet. It will be noted that in both cases the diver is raised more than half way to the surface in the first lift and that the wait at varying depths is more and more prolonged as the surface is approached. These two facts hold as general rules for ascent from any depth greater than 50 feet. From depths of less than 50 feet it is safe to come to the surface immediately if the diver has not been down for more than two hours.

Once at the surface the wearer of the rescue device is in no way dependent on the buoyancy of the breathing bag as the swimming vest alone will support him together with the apparatus for hours or days as may be required. In fact, if the breathing apparatus proves cumbersome it may be detached from the vest and thrown away. This will allow the man to float much higher in the water which is a great advantage particularly if the sea is rough.

Inasmuch as individual rescue apparatus in a form substantially as described has been adopted for submarines by several European countries, it seems strange that our navy does not provide the crews of our submarines with similar equipment. The European countries, however, are apparently far ahead of us in the development of diving apparatus in general. For example, the ordinary diving suit as used in this country, in which the diver is supplied with air pumped from the surface through a hose, was discarded in Europe years ago, and it has been entirely replaced with the self-contained diving suit in which the air is automatically purified by passage through a potash cartridge and revivified by oxygen in the same way as in the rescue apparatus already described. A front and back view of the suit are shown in the accompanying illustrations. This type of diving apparatus makes the diver independent of long and dangerous air hose and relieves him of the very considerable drag of the same which even in moderate currents is often sufficient to pull him off his feet. The helmet of the suit is fitted with a sound amplifier for telephonic connection with an attendant at the surface. The microphone is placed at one side of the mouth and the receiver opposite one ear. The telephone cable is made strong enough to be used as a safety line. A watch in the helmet shows the diver just how long he has been down. He has absolute control of his own air supply and can stay down from two to three hours, depending on how hard he works and his corresponding consumption of oxygen. In case of emergency he can come to the surface at any time by inflating his suit.

Diving operations with this type of apparatus are economical as no air-pump, pump-men, or air-line tender are required.

For work in swift currents where the drag on the telephone cable is considerable, the

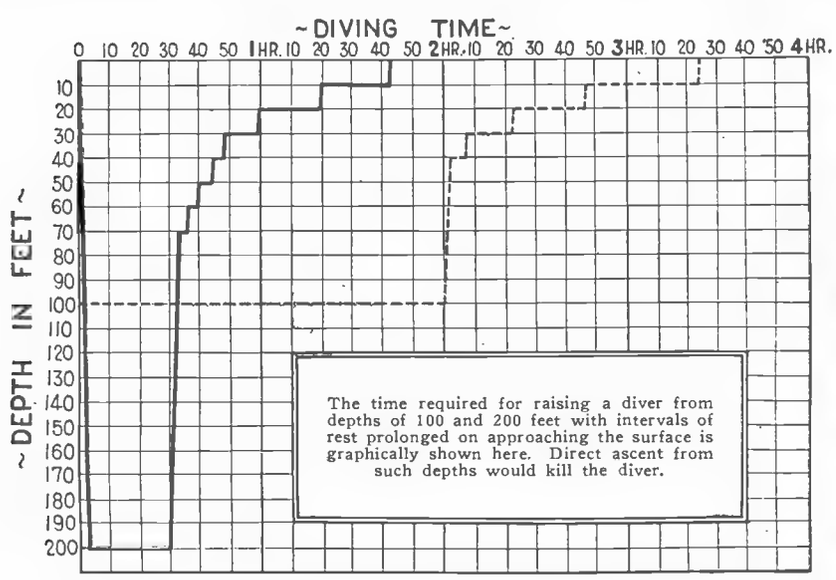


Rear view of an up-to-date diving suit showing oxygen tanks and potash cartridge for regenerating the air supply.

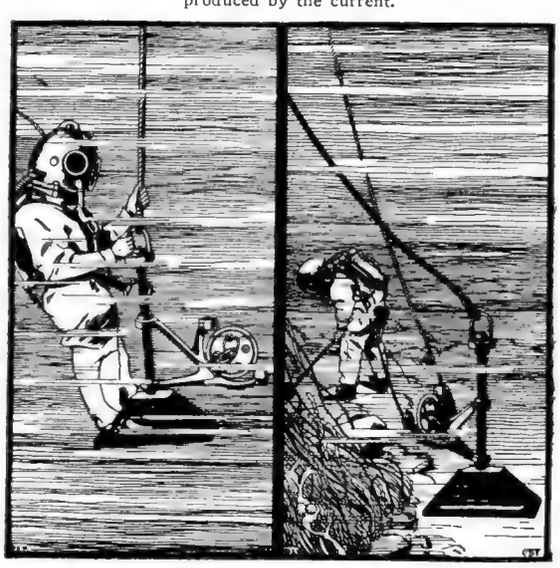
Germans have developed a ground pulley which relieves the diver of all vertical pull on the line. Its operation is illustrated in two accompanying sketches. The weight on which the pulley is mounted serves as a platform for the diver in descending, and on his arrival at the bottom he slips his telephone cable into the guides and over the wheel. He can then walk off in any direction as the pulley swings freely on its mounting shaft.

The rescue device for submarinists already described has been adapted in two interesting types for use in swimming pools or at bathing beaches and for hydroplanes. The swimming-pool apparatus enables the wearer to work half an hour under water or in high breakers. The entire equipment is carried on the back in order to allow maximum freedom for the arms. Air bags attached to the apparatus are filled according to whether the wearer wishes to dive or rise to the surface. The apparatus is made for mouth breathing.

The rescuer for hydroplanes is very similar in its construction but special attention has been paid to minimizing its weight. The equipment enables the fallen flier to swim or to breathe for 30 minutes under water, thus giving him sufficient time to free himself from his disabled plane.


~DIVING TIME~
0 10 20 30 40 50 1HR. 10 20 30 40 50 2HR. 10 20 30 40 50 3HR. 10 20 30 40 50 4HR.
~DEPTH IN FEET~
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
The time required for raising a diver from depths of 100 and 200 feet with intervals of rest prolonged on approaching the surface is graphically shown here. Direct ascent from such depths would kill the diver.

Diver descending on a weighted ground pulley. At work the diver uses the pulley to relieve all vertical drag on his life-line produced by the current.



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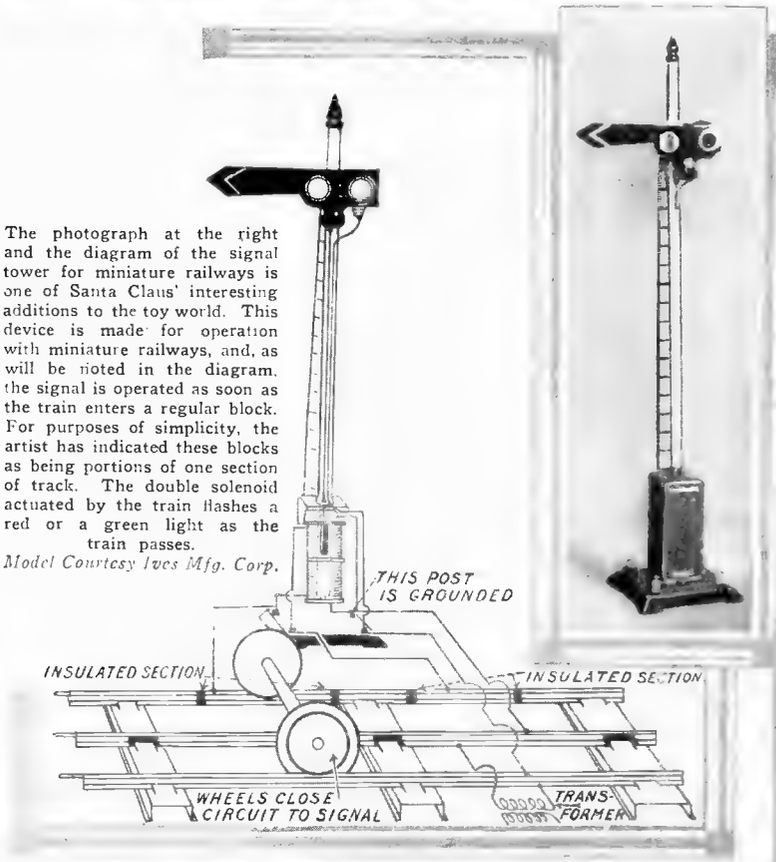
Scientific Santa

By JOSEPH

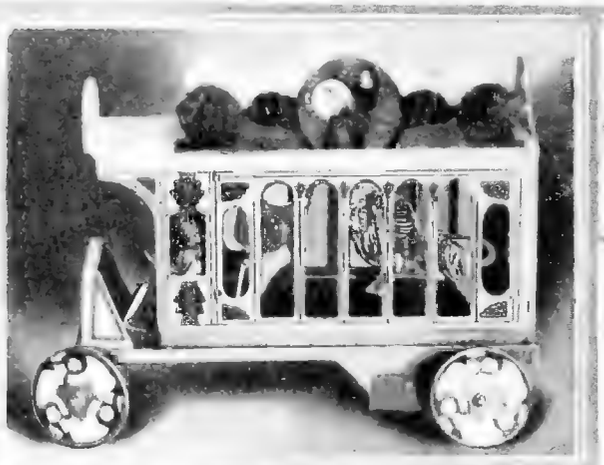
EACH year Christmas brings with it a lot of new toys to delight the youngster, and this year is no exception to the rule. As in the past, SCIENCE AND INVENTION Magazine again gives to its readers the details of a few of the best toys. So popular has our yearly toy page become that our readers anxiously look forward to it.

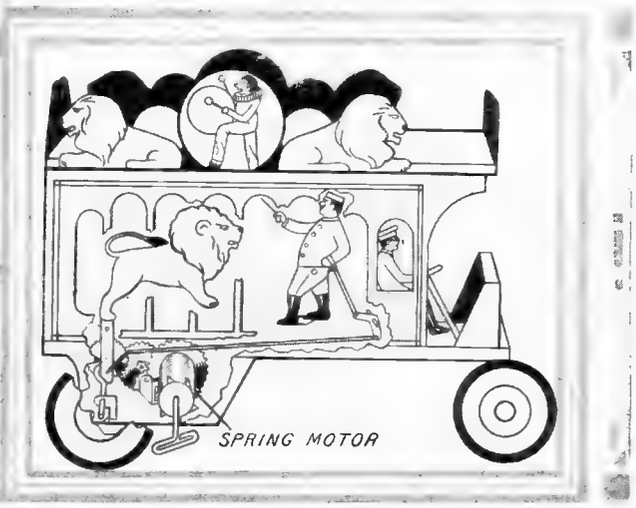
On these pages are illustrated an automatic electric railway signal of the semaphore type for toy train outfits. The arm is electrically operated by the train as soon as it enters a block. The two spring wound circus toys will be interesting to the younger folks. On the following page we illustrate a new type of electric train which may be automatically reversed by a button on the rheostat, and we also show a spring-operated porter and an automobile race track.



The photograph at the right and the diagram of the signal tower for miniature railways is one of Santa Claus' interesting additions to the toy world. This device is made for operation with miniature railways, and, as will be noted in the diagram, the signal is operated as soon as the train enters a regular block. For purposes of simplicity, the artist has indicated these blocks as being portions of one section of track. The double solenoid actuated by the train flashes a red or a green light as the train passes.

Model Courtesy Ives Mfg. Corp.





In the above illustration we find the details of a spring-wound toy in the form of a circus wagon containing a lion and its trainer. This toy may be wound up and it is not necessary to hold the wheels while the winding operation is being performed. As soon as the toy is placed on the floor, it starts to run, the lion moves up and down, and the trainer lashes his whip. The photograph of the toy is illustrated at the left. As may be seen by the photo, the device is pleasingly lithographed and there are no sharp corners to injure the smallest child. The wheels may be turned, causing the toy to travel in a circle when one is tired of watching it run straight along.

Model Courtesy Ferdinand Strauss Corp.

To the right we show a photograph and an illustration of the mechanism of a circus toy in which the master of ceremonies turns around and cracks his whip at the performers. Each time his arm goes down, either the performing animals or the clown go through their respective stunts. The elephant raises on his hind legs, the monkey slides down the pole, the lion stands up, but the clown will not spin around his horizontal bar until he is hit on the head. Notice in the mechanism that there is a lever with an arrow marked upon it, which turns around and raises the animals into their desired position. The clown is merely pivoted on his horizontal bar; consequently the crack from the performer's whip is necessary to make him spin around.

Model Courtesy Louis Marx & Co.

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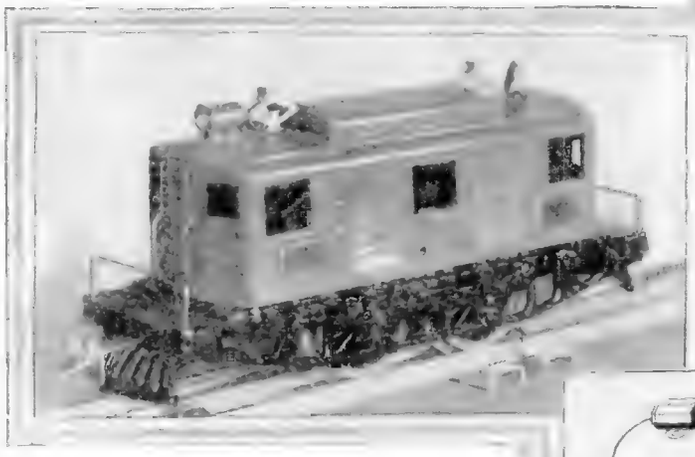
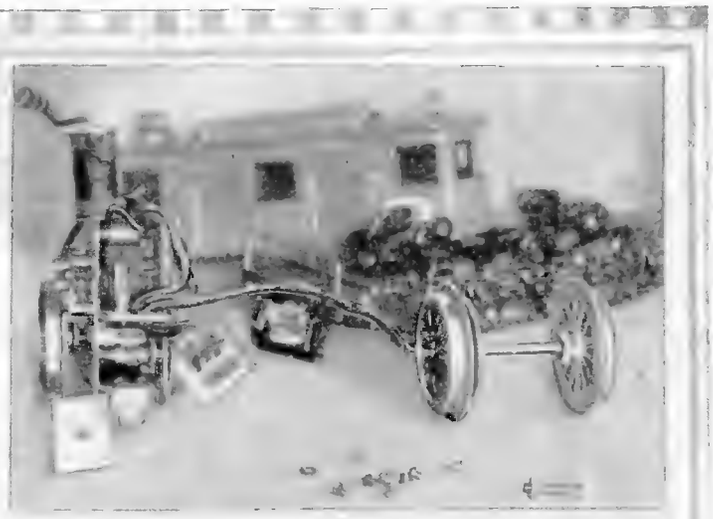
Delights Children

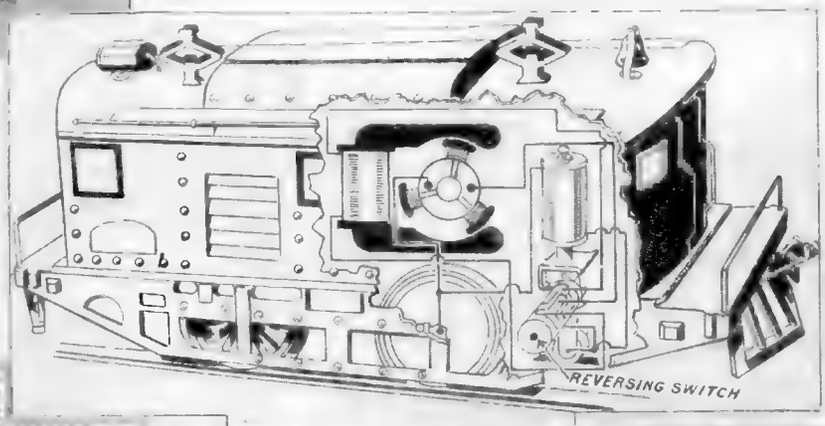
H. KRAUS

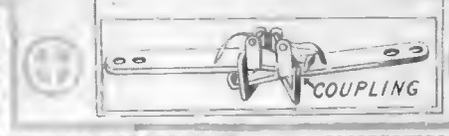


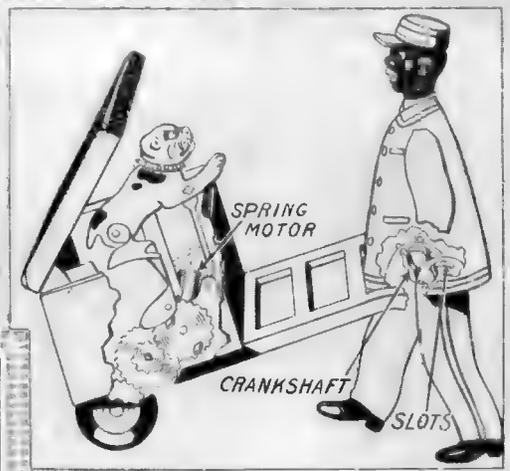


The two photos above and the diagram at the right show the latest type of electrical toy train which reverses automatically when a button on the rheostat is pressed. This button turns off the current to the rails momentarily, and allows an electro-magnetically controlled reversing switch to pull the switch around to the next position. Immediately the motion of the train is slowed up, the wheels begin to slip in the opposite direction, and finally the train runs backward along the track. This train is also fitted with automatic couplers illustrated in the drawing.

Model Courtesy Ives Mfg. Corp.

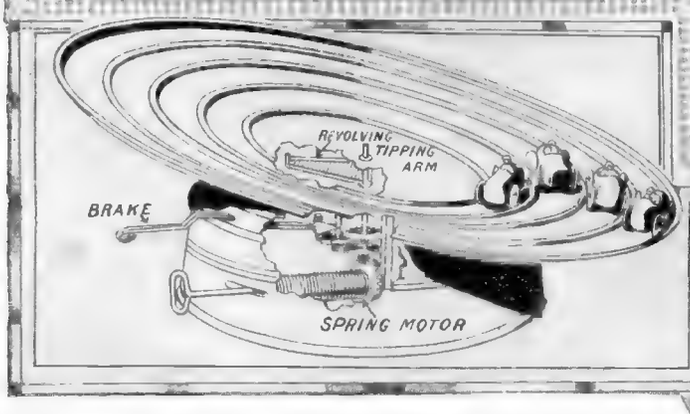






The photo and diagram at the left shows a mechanically operated porter pushing a trunk. As he moves along the floor, the cover of the trunk opens up and a dog seemingly growls at the porter, who hurries along with his burden. The mechanism is only applied to the wheels of the carrier, and yet one wonders at the remarkable way in which the porter walks along the floor. This is made possible through the ingenious crank movement to which the legs of the porter are fixed.

Model Courtesy Ferdinand Strauss Corp.



The turntable of the automobile race track illustrated above and to the right is caused to tip progressively by a small revolving tipping arm located immediately below the turn table. Four tiny automobiles are placed on the track and are caused to race around at a surprising speed. At times the innermost car will be in the lead, and at other times any of the other cars will take the lead.

Model Courtesy Louis Marx & Co.

Addresses of these toy manufacturers may be had upon request.

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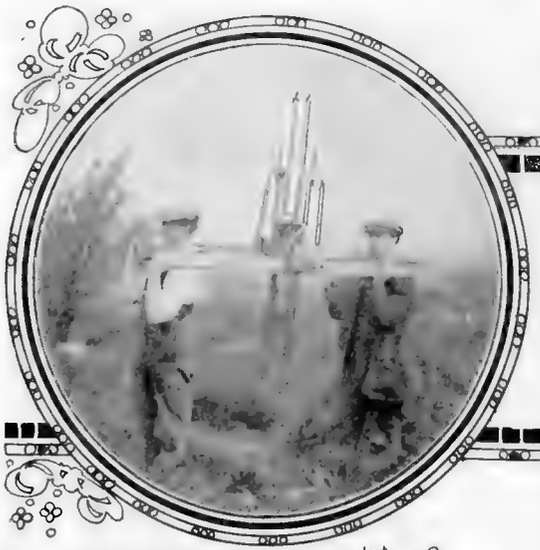
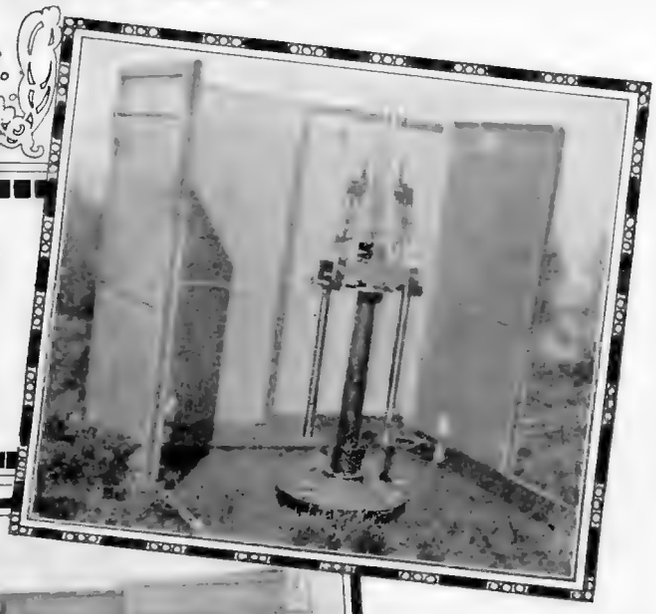
Mineral and Oil Finder

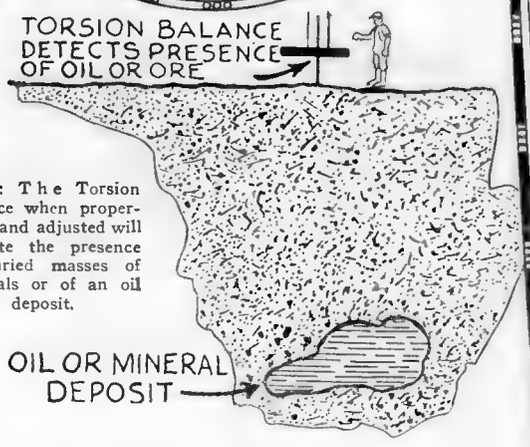


Left: The Eotvos Torsion Balance designed by Baron Roland von Eotvos of Budapest being taken into the field for testing its ability to locate oil and mineral deposits.



The balance is surrounded by a double or triple wall of metal sheets so that it will not be affected by outside disturbances. A deflecting mirror indicates the presence of minerals or oils.

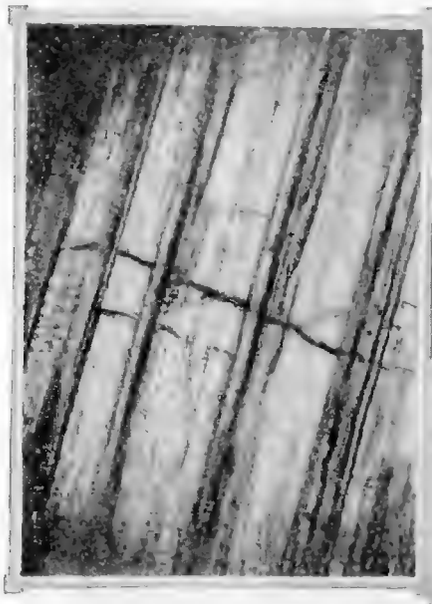
This device operates best at the edges of a deposit and therefore by proper manipulation can indicate approximate area.



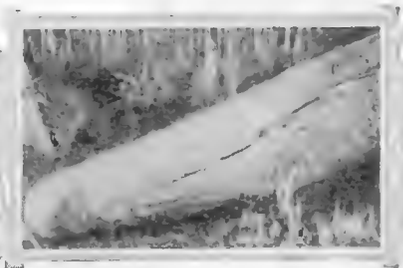
Right: The Torsion Balance when properly set and adjusted will indicate the presence of buried masses of minerals or of an oil deposit.

Machine Selects Wood

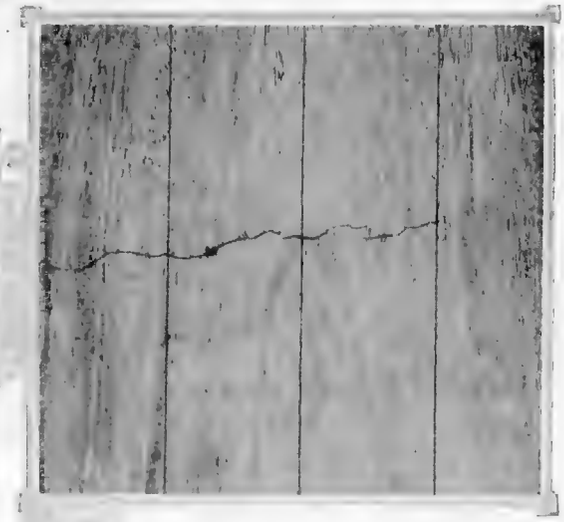
Right: Tree damaged by falling. This is a frequent cause of compression failure.

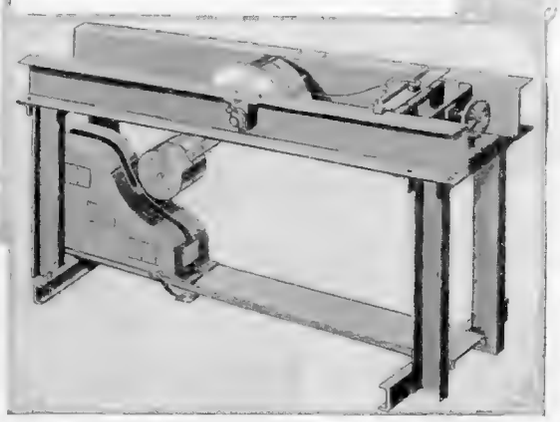


An enlarged view of a compression failure that was found in timber. This injury to the fibres was practically invisible to the naked eye but the microscope showed the fibres to be actually severed. This is shown in the enlargement above by the dark lines across the photograph.



The photograph at the right shows another compression failure that was so bad that it could be detected before the timber was put into use.





FAILURES of wood in building uses are due to many causes such as rough handling during the lumbering process, decay and some other natural causes. A machine that will aid in detecting flaws of various nature in timber has recently been designed and is in use in the forestry service of the Department of Agriculture. It is illustrated at the left. A cable that is wound up by the action of a pendulum is placed around the specimen of wood to be tested. Ordinarily when there is no specimen in the machine, the pendulum will swing through a certain arc when pulled back and released. When a specimen is under test, the pendulum does not swing as far as if it were free, but the arc through which it does swing indicates the breaking strain exerted on the wood.

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Railroad Wrecks in Movies

By FRANK GEORGE KERK

Wherein Capt. Kerk Explains How the Movie Producers Make Wrecks to Order

THE following explanation could be likened to cover a picture made by King Vidor, or the recent Metro-Goldwyn-Mayer production, "Excuse Me."

A scenario calling for a train to fall from a bridge over the canyon in Arizona or Colorado, could not have been accepted in the early days of motion pictures. It would have been impossible to get upon the films even could the producers afford the hundreds of thousands of dollars necessary to wreck a train and bridge. Then again the Santa Fé or other railroads might object to the destruction of their bridges, which took a long time to build.

Studio model maker constructing miniature bridge and following photograph for dimensions.

Today such a scenario is gladly purchased, as the thrill can be put over at a nominal cost of a few hundred dollars. The effects are obtained by means of a miniature bridge, figures and train which are exact reproductions, made to scale and perfect in every detail, and by using the slow motion camera. The action and scenes would be made in the regular way with the real train, bridge and canyon, up to the point where the destruction begins. Then the scene would shift from the real train and bridge to the miniature without the eye being able to detect the change. When the miniature is brought into play it is placed near the camera and taken slightly out of focus to deceive the eye of the careful and critical motion picture habitué and gives an illusion of the real thing at a great distance. It frequently happens that the result desired is not obtained the first time, so that it is necessary to build the miniature sets over and over again.

Model being destroyed for wreck scene. Insert shows how foundation is seemingly washed away.

The scenes of the real train and bridge would be taken "on location," as the technical term says, but the miniatures would be set up in the studio, or on the lot, and the camera would be placed very close, so that the ends of the bridge would exactly align with the ends of the bridge in the real scenes previously taken. The miniature train would then be run upon the bridge, which would collapse or do whatever the scenario called for and the train would proceed to do a nose dive to the bottom of the canyon. This is the point in operation in which the slow motion picture becomes essential.

According to natural laws a falling body will drop sixteen and a half feet the first second, forty-eight feet the next second, and ninety-six feet the third second and so on. For instance, the Canyon Diablo bridge is several hundred feet high, a train would take a certain number of seconds to fall that distance, and the camera would obtain sixteen pictures each second during the fall and the scene would look natural, but when you set up the miniature bridge and plunge your train off, it has only three or four feet to fall and following the natural laws it will reach the bottom of the canyon in a small fraction of a second and the camera running normally would obtain only two or three pictures during its fall to the bottom, which would be unnatural to the last degree and would not deceive any audience.

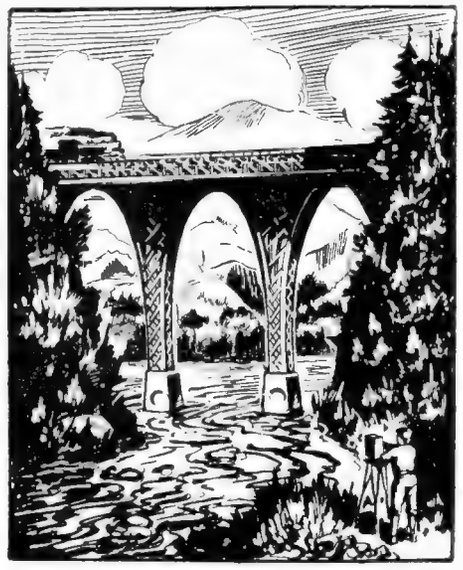
By computing the necessary number of pictures to be obtained to give it realism, the slow motion camera can be set to obtain that number of pictures in one-eighth or one-sixth of a second and the work of entertaining the public goes merrily on.

In order to cover details in construction of a miniature set we will assume the following as our own scenario briefly presented in abbreviation. The scene takes place over the Grand Canyon of Colorado—a railway bridge—heavy rains—washed out foundations. A train is half way across then falls from trestle hundreds of feet to the bottom of the canyon, depicting a terrible disaster. supposedly carrying hundreds of passengers to their death.

This would be accomplished in miniature by building a replica of a point in the Grand Canyon where the bridge is an actual fact. A still photograph of the real bridge would be taken for detail and notes of dimension, height, span and general appearance. In all operations of the construction of the miniature set, a careful scale would be adhered to. Where the bridge extended five hundred feet across the depths, the miniature set was constructed on a basis of three-eighths of an inch to a foot.

The material used to represent the steel girder construction of the bridge was sheet metal. For the railroad ties, wood was spliced and cut in proportion, then evenly spaced, after which they were set on flat strips that were bolted through to the floor of the stage and held the bridge in position until the destruction began. The rails were moulded or hammered out of metal strips. The appearance of heavy rains were obtained by a sprinkling can pouring its contents in front of the camera lens. The foundation base was boxed and a mixture of plaster of Paris and sand gave the appearance of a concrete foundation.

A heap of sand was placed around the foundation and the water rushing through the channel, around the foundation would carry the sand away and give the appearance of undermining the bridge. The washouts were accomplished by a small stream of water running through a channel in the canyon and fed by a fire hose. The actual falling of the bridge was obtained by the use of piano wires attached to the extreme top of the trestle and passing down through the stage and around a pulley to a lever built near the set. As the sand would wash away the foundation, the lever was pulled slowly, and drew a section of the bridge to a lower level, giving the effect of the actual falling of the real bridge.

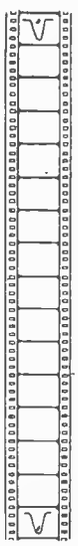


Photographs of the actual bridge are cut into the film to give semblance of reality.

As the train reached the section over the washed-out foundation, a final pull of the lever would send the train crashing to the bottom of the canyon. A "cut-in" of the actual scene would then show the actors swimming around a passenger coach on its side, some crawling through the windows and others falling over the side into the water and then to be pulled out to safety.

The actual enacted scenes, using cut-ins now and then as required, create the vivid illusions desired. As a rule the miniature trains are electrically driven, and smoke pots in the funnel give the effect of a locomotive in action.

The diagrams at the right show how slow motion photography makes it possible to use miniature models in various action scenes. For instance, as shown in frames at the immediate right, a small object falling a short distance would only register on a few frames at normal speed. Where slow motion photography is resorted to, the same action fills a large number of frames. Thus, the time element that would be consumed if the action being filmed was performed by life size objects, is duplicated by a combination of miniatures and slow motion photography.



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Tarrano the Conqueror

SIXTH INSTALLMENT

By RAY CUMMINGS

First American and Canadian Serial Rights

He turned to leave us, and I became aware of a woman's figure standing in the shadows of the archway across the room. She started forward as Tarrano glanced her way. A Venus woman of the Cold Country. Yet, obviously, one of good birth and breeding.

SYNOPSIS

THE story opens in the year 2325 and is related by Jac, a writer of that time, employed by a large news organization of Great New York. On the afternoon of May 12 of that year, the President of the Anglo-Saxon republic is murdered in the midst of a speech. This happened at 5:10 P.M. At 6:15 of the same day the ruler of Allied Mongolia is murdered. Ten minutes later the leader of the negroes of Africa is killed while asleep. This leaves the earth without leadership. Jac and Grayson, a co-worker of his, suspect that the murders are the result of a plot on the part of the inhabitants of Venus. At 8:26 the mail from Venus lands. At 8:44 a message by helio from that planet announces the murder of the ruler of the Venus Central State. A warning comes with the same message and reads in part, "City being attacked . . . Tarrano, beware . . . . you are in danger of . . ." The message stops at this point and further communication is impossible.

At 9 P.M. Jac is summoned to Northeast Island, off the coast of Maine, by a Dr. Brende.

Tarrano, the Doctor states, was at one time a lower official of the Cold Country of Venus. The doctor then announces that he, Brende, has perfected a medical method whereby human beings may be kept from growing old.

Unable to communicate with the Doctor's laboratory in northern Siberia, they set out for that point in Brende's aero. Arriving there they find no one outside and upon entering the laboratory building, are set upon by a group of "Venus-men."

In the ensuing battle, the Doctor is killed and Jac, Elza, the Doctor's daughter, and Georg, the Doctor's son, are taken from the laboratory by Argo, a Venus-man. They are transported in an aero to Venia, a city on the earth inhabited by people of Venus. Here they meet Tarrano, who orders Jac and Georg imprisoned, keeping Elza in his presence.

Jac and Georg are imprisoned and held captive by walls of electrical charges that effectively prevent their escape. They are soon joined by Elza and hear that the earth governments have issued an ultimatum to Tarrano.

Tarrano sends a note to the earth governments refusing to come to terms and stating that if war is declared upon him, he will destroy all of Dr. Brende's records and will kill Georg.

By signals the little party of earth people have communicated with a Princess Maida of Venus who is also Tarrano's prisoner. The Princess sends a friend to rescue Jac, Georg and Elza, and the friend, Wolfgar, throws an isolation barrage around them. Suddenly interference is encountered and the barrage broken down.

In the resulting confusion, Georg escapes and joins the Princess Maida. Together with her they flee from Venia by helicopter and are picked up by an airship of the earth government. They are taken to Washington under heavy guard. The next day Tarrano offers to return the papers and models of Georg's father's invention, branding young Brende as an imposter who knows nothing of the invention. To offset this accusation, Georg is to tell his story to the world as well as to Venus and Mars by radio and helio. He and Princess Maida go to the station but there they disappear.

CHAPTER XII

THE WOMAN TARA

I MUST revert now to those moments in the tower room when Tarrano dissolved the isolation barrage which Wolfgar had thrown around us. Georg escaped, as I have recounted. Tarrano—there in the tower room—rendered me unconscious. I came to myself on the broad divan of the same room, with Elza bending over me.

I sat up, dizzily, with the room reeling.

"Jac! Jac, dear——" She made me lie back, until I could feel the blood returning to my clammy face; and the room steadied, and the clanging of the gongs in my ears died away.

"I—why, I'm—all right," I gasped. And I lay there, clinging to her hand. Dear little Elza! In that moment of relief that I had come to my senses, she could not hide the love which even now was unspoken between us. Tarrano! I lay there weak and faint; but with the pressure of Elza's hand, I did not fear that this Tarrano could win her from me.

Wolfgar was standing across the room from us. He came forward.

"You did not die," he said; and smiled. "I told her you would not die."

It was now morning. Wolfgar and Elza told me I had been unconscious some hours. We were still imprisoned as before in the tower. Georg had escaped with Maida, they said; or at least, they hoped so. And they described the burning of the other tower. The city had been in a turmoil. It still was; I could hear now the shouts of the crowd outside. And turning as I lay there, through the casement I could see the blackened, still smoking ruins of Maida's tower; the broken iron terrace; the spider bridge melted away, hanging loose and dangling like an aimless pendulum.

The latest news, Elza and Wolfgar could not give me. The instrument room of our tower had been disconnected by Tarrano when he left some hours before. As they said it, we heard a familiar buzz; then the drone of an announcer's voice. Tarrano's guard had doubtless observed my recovery and had had orders to throw current into our instruments. Strange man, this Tarrano! He wished the news spread before us again. Confident of his own dominance over every crisis, he wanted Elza and me to hear it as it came from the discs.

We went to the instrument room. I found myself weak, but quite uninjured. Elza left us there, and went to prepare food which I needed to strengthen me.

The public events of those hours and days following, I have recounted as Georg saw them and took part in them in Washington. We observed them, here in the tower, with alternate hopes and fears. Our life of imprisonment went on much as before. Occasionally Tarrano visited us, always making us sit like children before him, while at his ease he reclined on our divan.

But he would never give us much real information; the man always was an enigma.

"Your friend Georg has a wonderful plan," he announced to us ironically early one evening. He smiled his caustic smile. "You have seen the tape?"

"Yes," I said. It was Georg's plan to address with Maida, the publics of Earth, Venus and Mars.

Tarrano nodded. "He and the Princess are going to convince everyone that I am an impostor."

My heart leaped into my throat. The woman Tara had produced from about her person a weapon of some kind.

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I did not answer that; and abruptly he chuckled. "That would be unfortunate for me—if they could do that. Do you think they'll be able to?"

"I hope so," I said.

He laughed openly. "Of course. But they will not. That long note of mine to your government—you read it, naturally. But you didn't read in it my secret instructions to my agents in Washington, did you? Well, they were there in it—my commands—the letters ending its words made another message."

He was amused at our discomfiture. "Simple enough? Yet really an intricate code in itself. It made the phrasing of the main note a little difficult to compose, that was all." He sat up with his accustomed snap of alertness, and his face turned grim. "Georg will never address his audience. Nor the Princess—she will never appear before those sending mirrors. I have seen to that." Again he was chuckling. "No, no, I could not let them do a thing like that. They might turn people against me."

Elza began indignantly: "You—you are——"

His gesture checked her. "Your brother is quite safe, Lady Elza. And the Princess Maida also. Indeed, they are on the point of falling in love with each other. Natural! And perfectly right. It is as I would have it."

His strong brown fingers were rubbing each other with his satisfaction. "Curious, Lady Elza—how fortunate I am in all my plans."

"I don't think you are," I said. "Our government has you a prisoner here. They didn't withdraw the patrol as you demanded, did they?"

He frowned a trifle. "No. That was too bad. I rather hoped they would. It would have been a stupid thing for them to do—but still, I almost thought they'd do it."

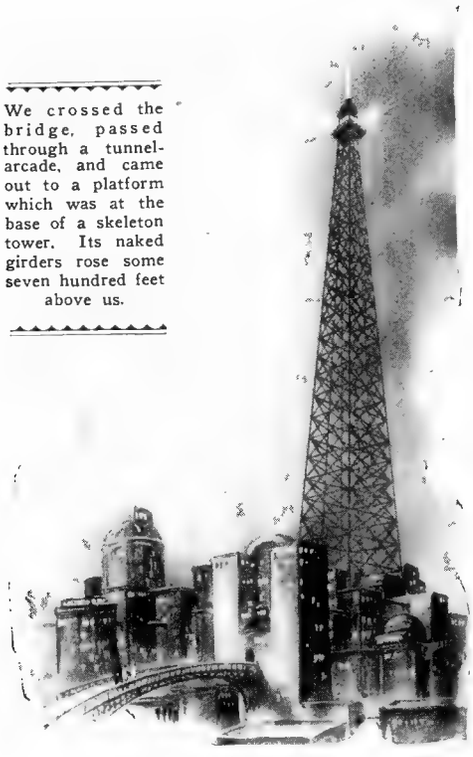
I shook my head. "What they will do is sweep down here and overwhelm you."

"You think so?"

"Yes."

He shifted himself to a more comfortable position. "They are playing for time—so that when I fail to produce the model as I agreed, then the public will realize I am not to be trusted."

"Exactly," I said.



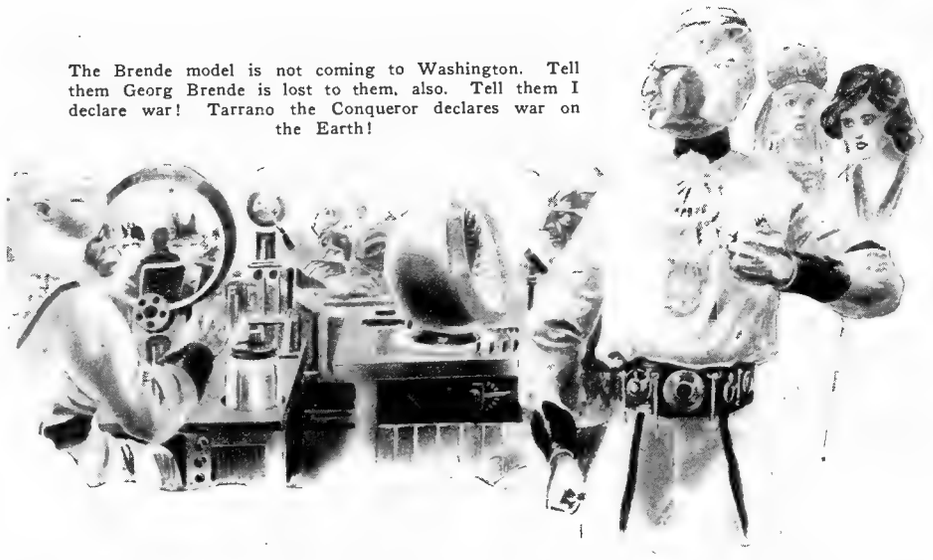
We crossed the bridge, passed through a tunnel-arcade, and came out to a platform which was at the base of a skeleton tower. Its naked girders rose some seven hundred feet above us.

"Well, I am playing for time, also."

He seemed so willing to discuss the thing that I grew bolder.

"What have you to gain by playing for time?" I demanded.

He stared. "You would question me, Jac Hallen? How absurd!" He looked at Elza, as though to share with her his amazement at my temerity.



The Brende model is not coming to Washington. Tell them Georg Brende is lost to them, also. Tell them I declare war! Tarrano the Conqueror declares war on the Earth!

Wolfgar said suddenly to Tarrano. "You will gain nothing."

Tarrano's face went impassive. I understood him better now; that cold, inscrutable look often concealed his strongest emotions. He said evenly:

"I should prefer you not to address me, Wolfgar. A traitor such as you—the sound of your voice offends me."

It struck me then as very strange—as it had for days before—that Tarrano should have failed to punish Wolfgar. I would have expected death; least of all, that Tarrano would have allowed Wolfgar to live here in the tower, in comparative ease and comfort. Tarrano's words now answered my unspoken questions. He was not looking at Wolfgar, but at Elza.

"You, Wolfgar—deserve death. You know why I cannot kill you? Why I let you stay here in the tower?" A faint, almost wistful smile parted his thin lips; he did not take his eyes from Elza.

"I am greatly handicapped, Wolfgar. The Lady Elza here would not like to have me put you to death. She would not even care to have me mistreat you. She is very tender hearted." He raised a deprecating hand. "Ah, Lady Elza, does that surprise you? You never told me I must be lenient with this traitor? Of course not."

"I——" Elza began, but he stopped her.

"You see, Lady Elza, I have already learned to obey you." He was smiling very gently. "Learned to obey even your unspoken commands."

I wondered how much of this attitude might be sincere, and how much calculated trickery. Could Elza, indeed, control him?

She must have had much the same thought, for she said with a forced smile: "You give me a great deal of power. If you—wish to obey me, you'll set us free—send us all to Washington."

That amused him. "Ah, but I cannot do that."

She gained confidence. "You are willing to be very gracious in things which do not inconvenience you, Tarrano. It is not very impressive."

He looked hurt. "You misinterpret. I will do for you anything I can. But you must remember, Lady Elza, that my judgment is better than yours. I would not let you lead us into disaster. You are a gentle little woman. Your instincts are toward humane treatment of everyone—toward mercy rather than justice. In all such things, I shall be guided by you. Justice—tempered with mercy. A union very, very beautiful, Lady Elza . . . But, you see, beyond that—you are wrong. I am a man, and in the big things I must dominate. It is I who guide, and you who follow. You see that, don't you?"

The sincerity in his voice was unmistakable. And my heart sank as I watched Elza. Her gaze fell, and a flush mantled her cheeks. Tarrano added quietly: "We shall have no difficulty, you and I, Lady Elza. Each of us a place, and a duty. A destiny together. . . ."

He broke off and rose quickly to his feet. "Enough. I have been weak to say so much as this."

He turned to leave us, and I became aware of a woman's figure standing in the shadows of the archway across the room. She started forward as Tarrano glanced her way. A Venus woman of the Cold Country. Yet, obviously, one of good birth and breeding. A woman of perhaps 30 years, beautiful in the Venus cast; dressed in the conventional bodice breast-plates and short skirt, with grey stockings and sandals.

Within the room, she regarded Tarrano silently. There was about her a quiet dignity; she stood with her tall, slim figure drawn to its full height. Her pure white hair was coiled upon her head, with a rich metal ornament to fasten it. And from it, a mantle of shimmering blue fabric hung down her back.

Tarrano said: "What are you doing up here? I told you to wait below."

Her face showed no emotion. But there was a glitter to her eyes, a glow in their grey depths like *alumite* in the hydro-flame of a torch.

She said slowly: "Master, I think it would be very correct if you would let me stay here and serve the Lady Elza. I told you that before, but you would not listen."

Tarrano, with sudden decision, swung toward Elza. "This is the Elta* Tara. She was concerned that I should allow you to dwell here alone with this Jac Hallen, and this traitor from Mars." His tone conveyed infinite contempt for us.

The woman said quickly: "The Lady Elza would be glad of my companionship." She shot a swift glance to Elza. What it was meant to convey, I could not have said. Perhaps Elza understood it, or thought she did. She spoke up.

(*Continued on page* 754)

*Elta—a term or title denoting rank by birth.

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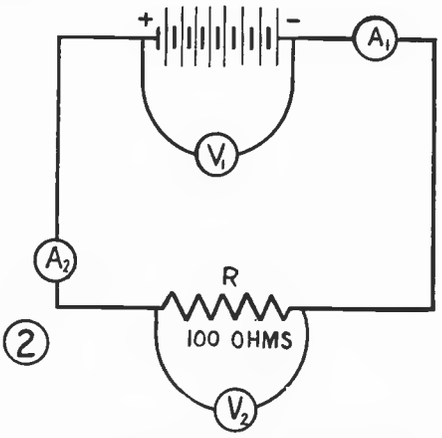
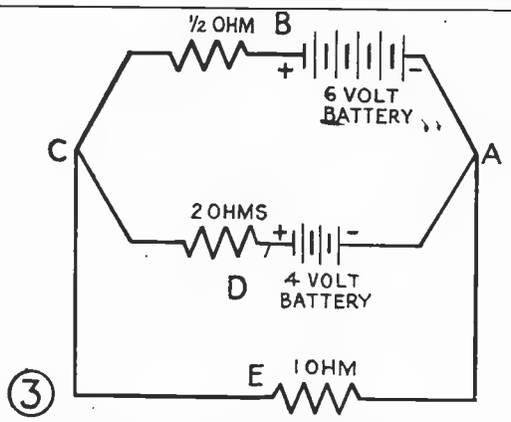
Scientific Problems and Puzzles

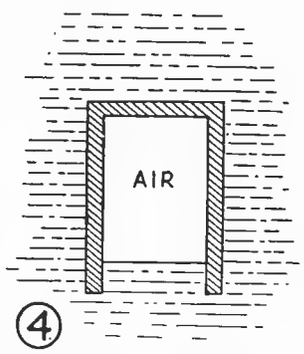
By ERNEST K. CHAPIN



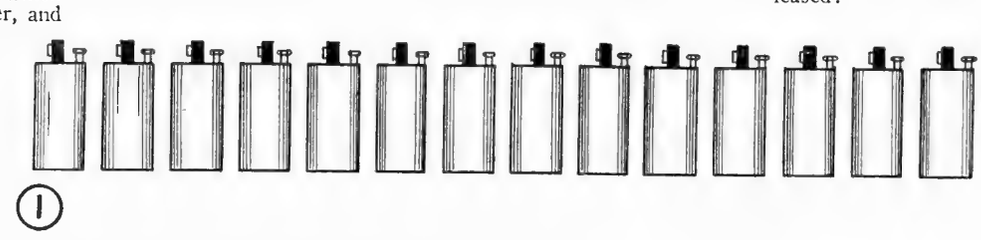
In the circuit shown in Fig. 2 above, two volt meters and two ammeters are connected in a circuit with a battery and resistance. In this particular case, which ammeter, if either, will read higher, and which volt meter?



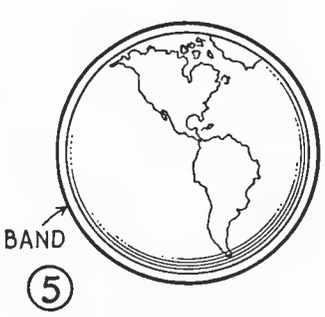
Considering the resistance of the battery and the connecting wire as negligible, which way will current flow through the branch of the circuit ADC? What effect could a change in resistance in ADC have upon the flow of current in this branch?



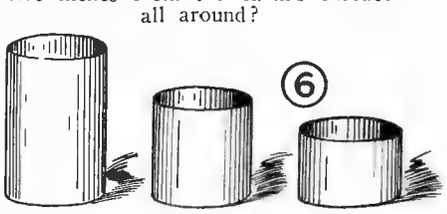
A cylindrical can, opened at one end is light enough so that it will tend to float as above. Can the can be pushed to a sufficient depth so that it will not rise when released?



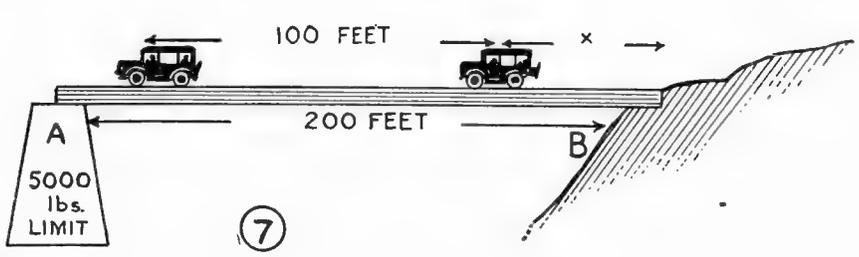
Given 14 dry cells without connections between them, can you arrange them in a circuit and connect them together so that the resulting battery so formed will have an E.M.F. of 9 volts total? Of course, in this case we are assuming the use of standard carbon-zinc dry cells which have a practical voltage of 1.5 each. In solving this problem, you can resort to any series or parallel connection or combinations of the two.



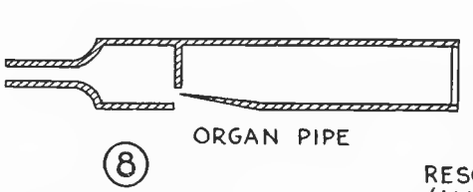
Assuming an inelastic band around the earth as above, and that the band is cut and an additional yard added, could the band be raised as much as five inches from the earth's surface all around?

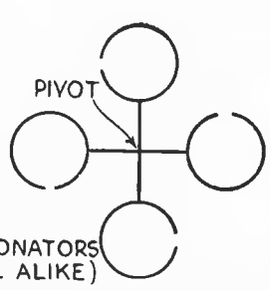


Should the diameter of a cylindrical can exceed, equal or be less than the height if the result is to have the most volume for the amount of material used in producing the can?

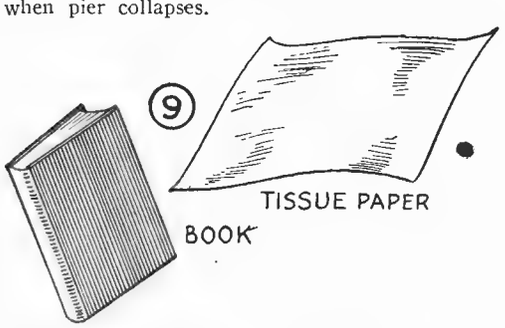


Assuming two cars on a bridge as above, with the various known factors indicated, will the pier A give way, providing both cars keep the same distance apart as indicated, and how far will the rear car be from the end B when the bridge gives way? In other words, solve the problem for the distance X when pier collapses.





If four resonators are mounted on a pivot so that they are perfectly free to rotate and if they are all alike, which way will they tend to rotate when a blast is blown on an organ pipe to which they are tuned?



Can a sheet of tissue paper be arranged so as to support a book several inches above the surface of a table?

(*Answers to these problems given on page 767*)

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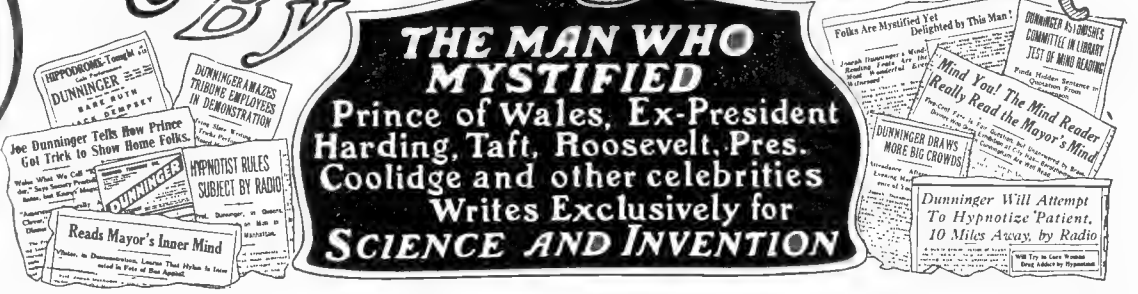
MAGIC By "DUNNINGER"

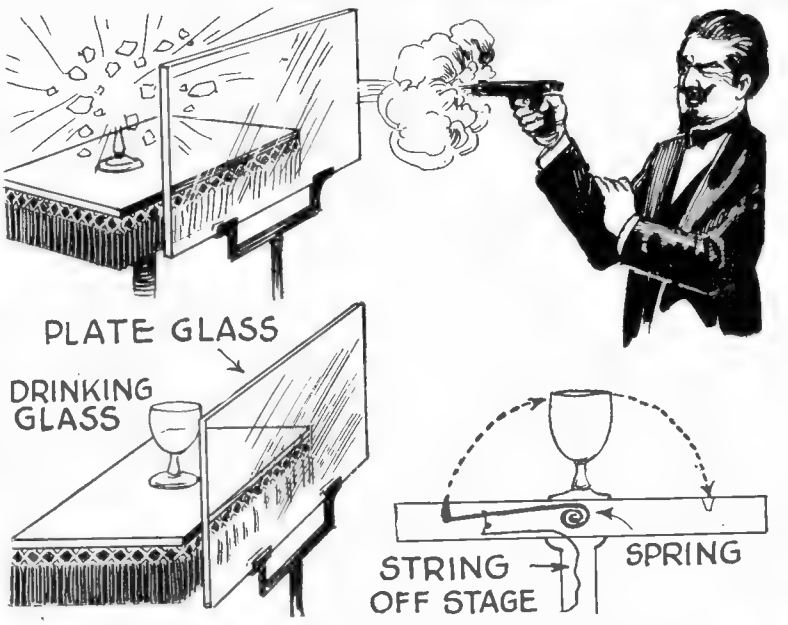

HIPPODROME-Tonight
DUNNINGER
BABE RUTH
JACK DEMPSEY
DUNNINGER AMAZES TRIBUNE EMPLOYEES IN DEMONSTRATION
Joe Dunninger Tells How Prince Got Trick to Show Home Folks.
DUNNINGER
HYPNOTIST RULES SUBJECT BY RADIO
Reads Mayor's Inner Mind
Folks Are Mystified Yet Delighted by This Man!
DUNNINGER ASTONISHES COMMITTEE IN LIBRARY TEST OF MIND READING
Mind You! The Mind Reader Really Read the Mayor's Mind
DUNNINGER DRAWS MORE BIG CROWDS
Dunninger Will Attempt To Hypnotize Patient, 10 Miles Away, by Radio

THE MAN WHO MYSTIFIED

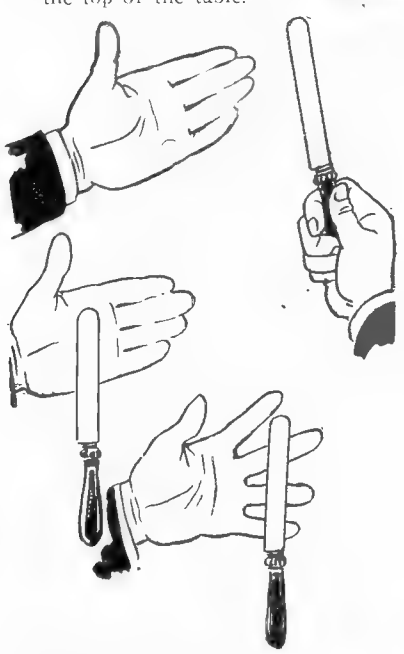
Prince of Wales, Ex-President Harding, Taft, Roosevelt, Pres. Coolidge and other celebrities Writes Exclusively for SCIENCE AND INVENTION

NO. 33 OF A SERIES

At the right is illustrated a new method of apparently shooting through a sheet of plate glass, and breaking a tumbler on the other side of it. It will be noticed that on the table an ordinary drinking glass is to be seen. In front of this a sheet of plate glass is held by a suitable holder. The magician picks up an automatic revolver and fires directly at the tumbler, which is seen to burst. The plate glass remains undamaged. The effect is produced by having a specially prepared table arranged with a spring trigger as illustrated. At the end of the spring a pointed weight is to be found, which spring when released by the assistant, comes up and breaks the glass tumbler. The revolver is loaded with blank cartridges. The spring flies into a groove provided for it in the top of the table.

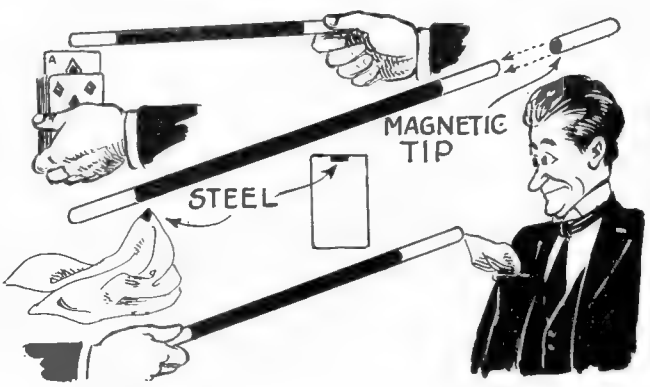


Below we find a new method for securing a "load" from an ordinary opera hat. A load, as every magician knows, is anything which the magician desires to produce for use in future tricks or with which he is attempting to make a hit. It may be silks, flags, flowers, rabbits, baby's clothes, vegetables, ribbons, or anything else. The opera hat from which this load is produced has a specially hinged compartment, which slides from the inside to the outside of the hat, as can be seen by referring to the diagram below. In this hinged compartment the load is located. When the inside of the hat is shown, the load naturally is pushed to the outside, where it is hidden under cover of the hand of the performer. A flip of the hat transfers the load to the inside to be removed at will.



The above shows an interesting little parlor trick which may be performed around the dining table. The amateur picks up a knife, rubs it briskly on the palm of his hand and then suspends it from the finger tips, from the palm or from the back of the hand in a very mysterious manner. A very weak solution of seccotine and water is applied to the palms and fingers and allowed to dry. This is sticky enough to cause the knife to stay in any prescribed position.

The illustration below shows a new type of magic wand. Any ordinary magic wand may be used in constructing a device of this nature. The performer should have a good selection of magic wands, and they should all be similar in appearance, so that he can employ one or the other whenever needed, and the change in the selection of wands will be scarcely apparent. Strange as it may seem, a great many tricks may be done with wands alone. Thus we have a type of wand which defies gravity and will remain suspended in almost any position from the edge of the table, chair or book. Then there is the disappearing wand and the rising and falling wand, and countless other styles which in themselves make a very pleasing exhibition. Here, however, we have a tip which may be added to any wand, and with which two or more interesting tricks may be added to the magician's repertoire. The metal tip of the wand below is fitted with a bar magnet of the permanent type. This causes cards specially prepared with strips of clock spring attached to their backs to cling to the wand. The magician may also put a silk kerchief into the pocket of his assistant and withdraw it with the wand to which the silk clings mysteriously.



The hat illustrated in the drawing above may also be used for the production of eggs in one of two ways. Two or three real eggs may be placed in the compartment, and the others may be of a collapsible spring type, or the performer may drop the real eggs into the compartment on the outside of the hat, push the compartment into the hat, and extract the eggs from the inside. The eggs may be secured from the vest or from a "servant" attached to the back of a chair

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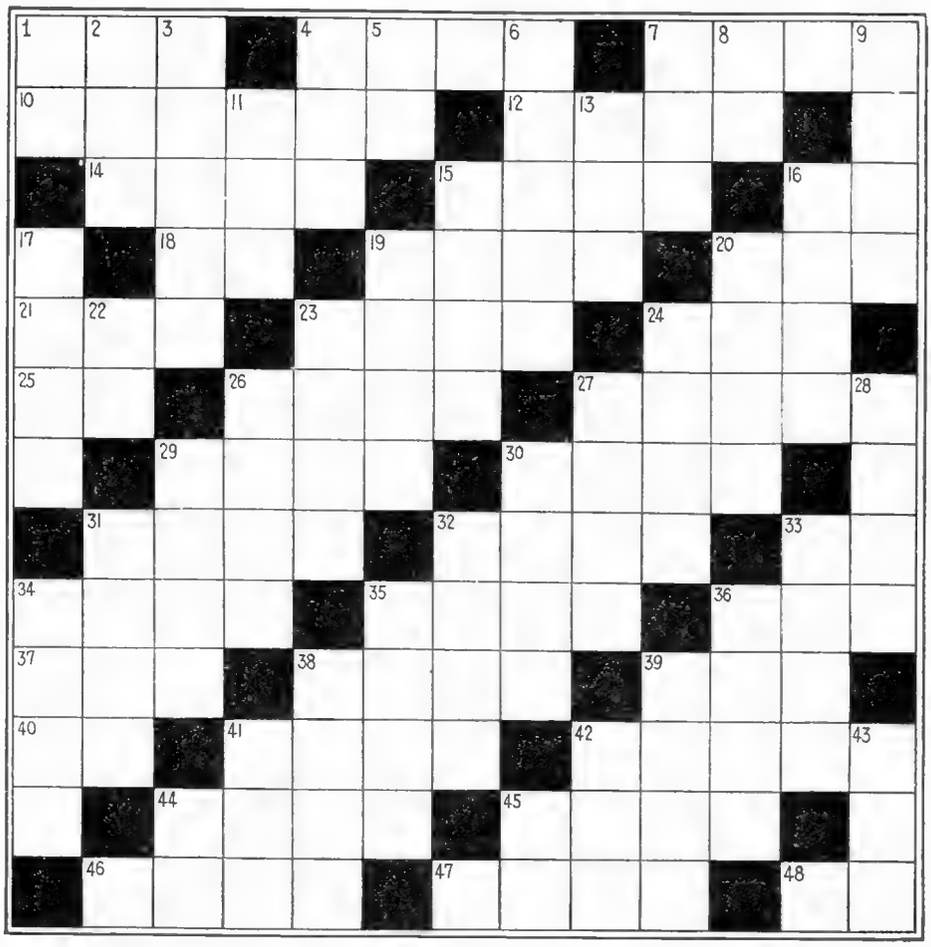
Mathematical Cross-Number Puzzle

By RICHARD H. TINGLEY

Here you are, cross-word puzzle fans, here is a puzzle that will tax your ingenuity to the utmost. The answers are given on page 752, but for your own sake do not refer to them until you have finished the puzzle or exhausted your fund of information. This puzzle is radically different from the usual type in which letters are inserted in blank space to form words. In this one, definitions are given which, by dint of hard thinking, can be worked out into numerals which numerals are inserted in the correct order in the blank spaces and which will line up both vertically and horizontally in the same way as the letters do in the ordinary cross-word puzzle. The first answer, 1 horizontal, is 3.11. We have named this new brain teaser "Cross-Number Puzzle."



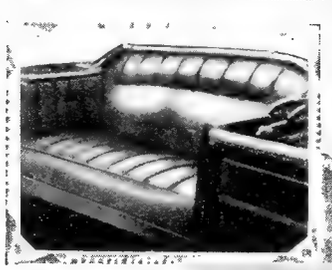
HORIZONTAL

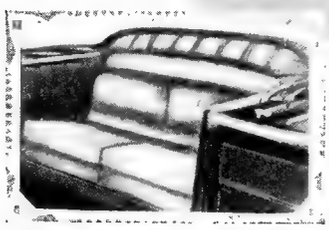
1—One quarter of the cube root of the present year; decimal after the first figure.
4—One hundred and thirty-eight poles plus ten feet.
7—The year the World War began.
10—Twenty-three sixty-fourths in decimals; decimal before the first figure.
12—The cube root of sixteen hundred and forty-three; decimal after the second figure.
14—The number of Troy ounces in six hundred and sixty-eight pounds.
15—Ninety-three less than the cube of thirteen.
16—The number of squares in a chess board.
18—The square root of .0064; decimal in front of the first figure.
19—The third musical note.
20—The number of days from June 20th to May 20th.
21—The number of degrees in a semi-circle.
23—Fifty-two sixty-fourths in decimals; decimal before the first figure.
24—Subtract eighteen from the square of twenty-nine.
25—The abbreviation for the island upon which is a portion of New York City.
26—The beginning of the era of Abraham, B. C.
27—Add sixty to the number of cubic inches in 384 gallons.
29—Six hundred and fifty-four years ago.
30—Fifty-eight ten-thousandths more than the square of twenty-five hundredths; decimal before the first figure.
31—MDCCCIII.
32—CCLXXVI years ago.
33—The year of the destruction of Jerusalem, A. D.
34—The year of the fall of the Bastile.
35—The late President Harding was elected in this year.
36—The number of men in the "Charge of the Light Brigade."
37—The reputed age of Methusela; Genesis v-27.
38—Five less than ten milleniums.
39—CCII.
40—The number of Troy ounces in a pound.
42—The number of feet in ten miles, plus the number of feet in 2,812 yards.
44—Express two hundred and three meters in inches; then add four.
45—The number of pounds in the ton of coal the dealer doesn't sell to you.
46—Seven hundred and thirty-six years before Paul Revere's ride.
47—The year of Our Lord it will be ninety-five years from now.
48—The maiden of Greek mythology whom Hera turned into a heifer because her husband, Zeus, was too fond of her.

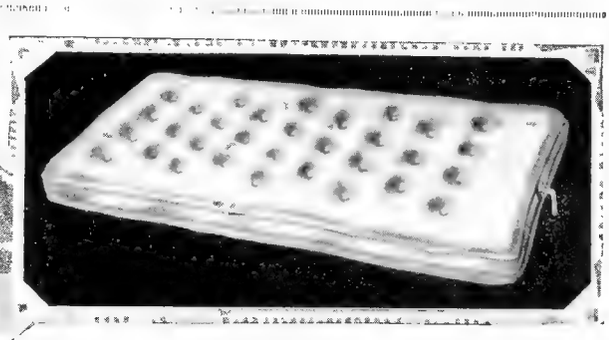
VERTICAL

1—The sum of money a man would earn by working 22 hours on a 40 hour per week schedule, at $60 a week.
2—Eleven less than the square of the so-called unlucky number.
3—Two M's with a C between them; then multiply by ten.
4—The number of days from May 3 to February 3.
5—The square of V.
6—A roadway 2,000 feet long by 35.5525 feet wide contains how many square feet.
7—The number of days from the regular inaugural day of the presidents to September 4th.
8—The number of years it will take a dollar to be worth $1.68 at 6 per cent. compound interest; decimal between the two figures.
9—Four IV's in a row.
11—Six times as old as President Coolidge was on July 4th, 1925.
13—The third letter in the alphabet, followed by a personal pronoun, first person singular.
15—The square of .45; decimal in front of the first figure.
16—Three hundred and ninety-six avoirdupois ounces.
17—1,872 ten thousandths part of an acre in feet.
19—Forty-five years after the Battle of Hastings.
20—The amount of money due a workman for 24 days labor at the rate of $60 a week of 44 hours; decimal following the second figure.
22—Three cubic yards.
23—Two hundred and ninety-nine cubic yards.
24—The interest for eight days at 4 per cent., based on a year of 360 days in dollars; decimal before the first figure.
26—The square of forty-seven.
27—The number of cubic feet in three hundred and twenty cubic yards.
28—The square root of 1840; decimal in the middle.
29—Fourteen cords and ninety-seven feet more.
30—Four sixty-fourths expressed in decimals; decimal before the first figure.
31—One hundred and six and seventy-nine hundredths poles in feet.
32—Seventy years hence.
33—Add seven to the number of cubic feet in forty-seven cords.
34—The year the Lusitania was sunk.
35—The specific gravity of pure gold; decimal in the middle.
36—The par value of a Netherlands guilder in U. S. money; decimal before the first figure.
38—Set down four personal pronouns first person singular, followed each, by a saw-horse, all in a row.
39—A hundred pounds short of a long ton.
41—Par value in cents of a Roumanian leu.
42—The year Mohammed fled from Mecca.
43—The number of pounds in 50 Troy ounces.
44—Square IX and subtract XI.
45—The number of years it will take a dollar at 5 per cent. compound interest to amount to $2.65.

(Continued on page 752)







Pneumatic Auto Cushions

An English concern has recently adopted pneumatic cushions for use in their automobiles. The cushions, illustrated herewith are said to be most comfortable and can be obtained with various types of coverings. Made only of the best of materials, they will invariably outlast the car in which they are used.

AmericanPatentHistory.Com

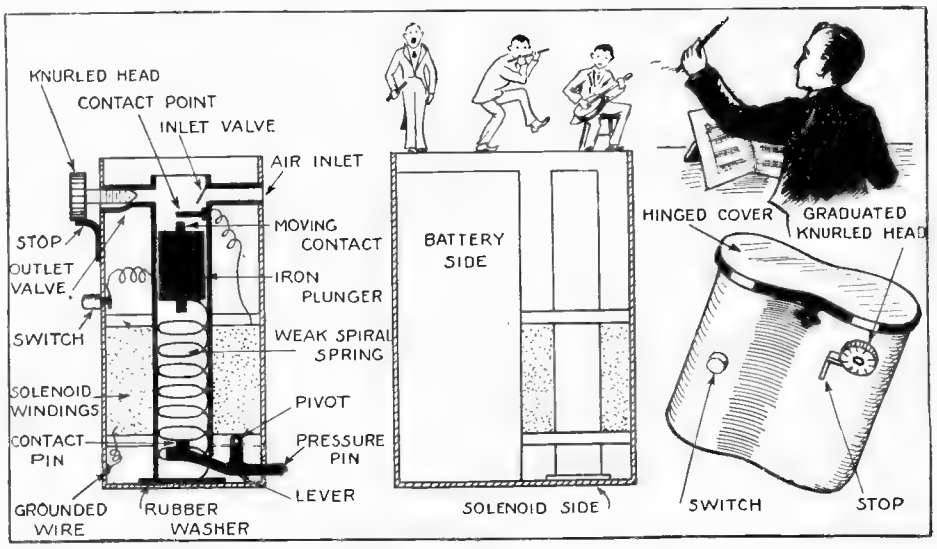
THE CONSTRUCTOR

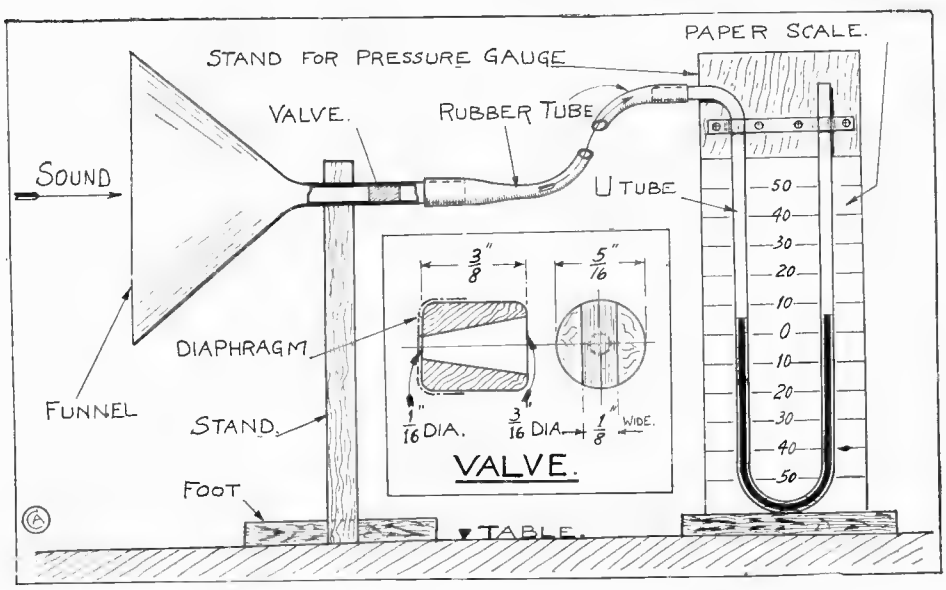
Window Control

SO THAT the window can be easily opened and closed without the necessity of arising from bed, the installation illustrated at the left may be put into place. By turning the wheel, the window may be opened or closed. The installation is quite simple, only requiring a few pulleys, rope and other odds and ends that can be plainly seen at the left. The control wheel and its attached drum are fastened rigidly to the wall, yet not so tightly that they cannot be turned. The ends of the rope are wound around the drum as shown in the upper left-hand corner and the center of the rope is fastened to the lower sash. Turning the wheel will wind up one end of the rope and unwind the other. The rest of the rope will then, of course, run through the pulleys and will lift or lower the window sash, according to the direction in which the wheel is turned.—*Edward L. Salmon.*

Pocket Metronome

AN INSTRUMENT which will aid the amateur orchestra conductor in preserving correct time can be made by following the diagram at the right. The device is carried in the waistcoat pocket and arranged so that the pressure pin will press against the leader's body periodically. The action of the device is obvious and the time between beats of the pressure pin is changed by turning the knurled knob which controls the size of the air outlet valve. When the plunger is going downward it has little air impedance, but on the upward stroke the inlet valve closes and the air in the chamber escapes only through the outlet valve.—*Dr. Russell G. Harris.*





Sound Gauge

IN VARIOUS physical experiments, it is desirable to be able to measure in a comparative way the volume of sounds. With the simple arrangement of apparatus illustrated at the left, this becomes practicable. A funnel is used to collect the sound waves so as to make the instrument more sensitive, whereupon the waves strike upon the diaphragm in the valve and cause variations of the column of colored liquid in the U-tube. The valve consists of a plug of wood having a small tapered hole drilled in it of the size and shape shown. A thin rubber diaphragm is stretched across the small opening and fastened in place. The paper scale back of the U-tube is calibrated by a comparison method, or in any other way that the experimenter may desire to employ.—*C. A. Oldroyd,* Reporter No. 4433.

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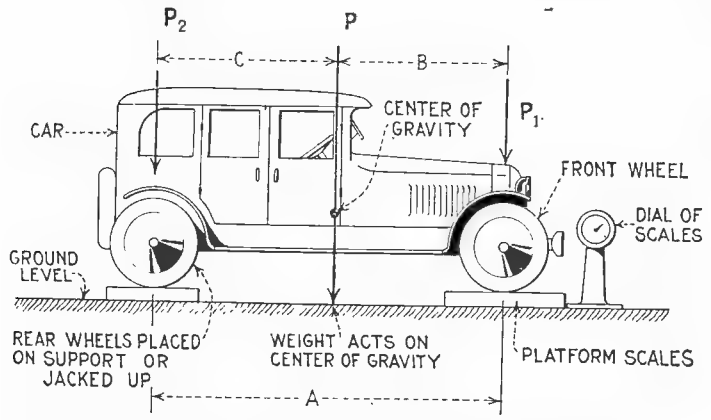
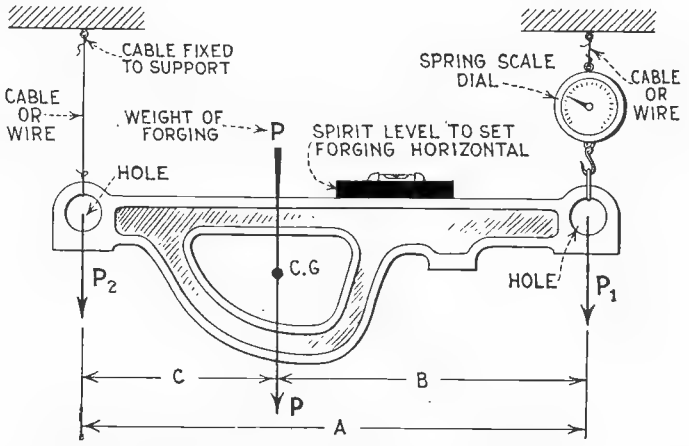
Finding the Center of Gravity by Experiment

By C. A. OLDROYD, Reporter No. 4433.



The finding of the center of gravity of an automobile may seem to be a hard problem, but if approached properly it is easily solved.



Above: Finding center of gravity of an irregular forging.

FREQUENTLY, the center of gravity of a car, forging or other item is to be found. To do so by calculation requires a great deal of time and effort, as every single component of the subject must be weighed first, or worse still, its weight must be worked out from the drawings, if no additional parts, as in the case of a car, are available.

At best, such results are not very accurate, as calculated weights differ more or less from the actual finished weights.

There is, however, a simple way of avoiding tiresome calculations and waste of time, namely finding the position of the center of gravity by experiment. This method presupposes of course that a finished car, forging, etc., is available.

Fig 1 shows the method applied to a forging. The shape shown is a complicated one, and would need many hours' calculation. We select the shorter way and determine the position of the center of gravity experimentally.

Through the two holes at the ends of the forging, cables or wires are passed, and from them the forging is suspended. On the left, we have a clear run of wire to the roof structure or other support, on the right, however, a spring balance is connected to the two short wire ends, so that it indicates the tension in the wire.

The forging is now adjusted, by means of a spirit level, so that its plane surface is horizontal. The forces acting in the system are shown in the drawing, the total weight of the forging is "P," this is either already known or can be found by weighing it.

The tension in the right wire is "P_1," in the left one "P_2." The as yet unknown center of gravity is at the distance "B" from the right wire, and "C" from the left one. The distance between the two points of support (here holes), is "A."

The law of leverage tells us that: $P_1 \times A$ equals $P \times C$, if P_1 is read off the dial of the spring balance. C. can be found; it is:

$$C = \frac{P_1 \times A}{P}$$

"B" is now also known, for it is: $A - C$.

This simple calculation gives us the actual position of the center of gravity in far less time than any other method. It can be used in nearly every case, as an indication of the flexibility of the method, a second case is shown in Fig. 2; namely, finding the center of gravity of a car.

For the theoretical man, this is "some" problem, particularly if the position of the C.G. is to be found under different conditions, as for instance, with passengers in the car, or arranged in various ways.

Experimentally, the problem is as simple as the first.

We wheel the front wheels of the car on a platform scale, and jack up the back wheels, or else place them on a few pieces of timber. With a spirit level we set the frame horizontal, measure the distance "A" (from center of axle, rear to front) and read off the dial of the scale the front load "P_1." The calculation is then as given above.

The application of this method is so wide that it will be unnecessary to give further examples, it may only be mentioned that it is very handy for finding the center of gravity of rowing or motor boats; in the latter case the influence of shifting the position of the engine can be easily studied. A well-known airship engineer has adopted this method for finding the center of gravity of airship power cars, containing the gears, engines, etc. The accuracy of the experimental method over theoretical means was most pronounced.

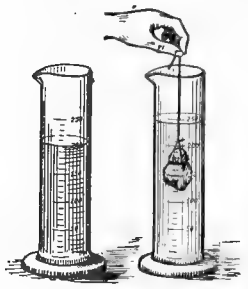
The Specific Gravity of Solid Bodies

THE specific gravity of a body is stated as the weight of a cubic centimeter in grams. Thus if 15 cubic centimeters of a body weighs 30 grams, its specific gravity is 2. If we weigh a stone on a letter scales and find, for instance, that it has a weight of 120.8 grams, all we need to know is the volume occupied by this stone in order to estimate its density or specific gravity. For this purpose we can use what the chemist calls a measuring cylinder, or a cylindrical glass vessel graduated on the side in cubic centimeters. Such vessels are used not only by chemists but by photographers, and one is shown in Fig. 1. We fill the vessel to a definite height, for instance, 200 centimeters. We fasten our stone to a very thin thread, or it may even be a long hair, and note how much the water rises when the stone is immersed in it, also shown in Fig. 1. Suppose the water rises to the mark indicated, 241.4 cubic centimeters, then the stone has a volume of 41.4 cubic centimeters. The specific gravity is 120.8 divided by 41.4, which equals 2.9. That is to say, a cubic centimeter of the stone weighs 2.9 grams.

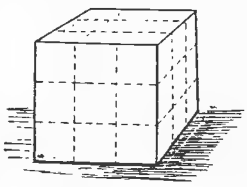
If the substance to be examined is soluble in water, such as a crystal of alum or Rochelle salts, or anything of that sort, oil is used in the cylinder.

If we have pulverized or dust-like materials to work with, difficulties appear. The best thing to do then is to take a container of known contents, say of 1,000 cubic centimeters, whose weight is known, and it will be easy enough to weigh it. The container is then filled with the dust or powder whose specific gravity is to be determined. It may be pulverized coal. The container is filled exactly even with the top and a second weighing gives the weight of its contents by subtracting the weight of the vessel from the last weight. Now if the weight of the coal dust, of course without including the weight of the container, is 2,100 grams, we know that the same volume of water weighs 1,000 grams, and the density or specific gravity of the coal is 2.1. But it will be found that pulverized material may have different densities according to how hard it is pressed down, when one is evening it off with the top of the vessel.

(*Continued on page 765*)



The specific gravity of bodies that are heavier than water can be determined by actual measurement of their volume if the diagram at the right is followed; the method is explained in the text.



When the specific gravity of objects that are lighter than water is to be obtained, it can be done by direct measurement and weighing.

Obtaining the exact diameter of wire is often done by measurement as shown directly above.

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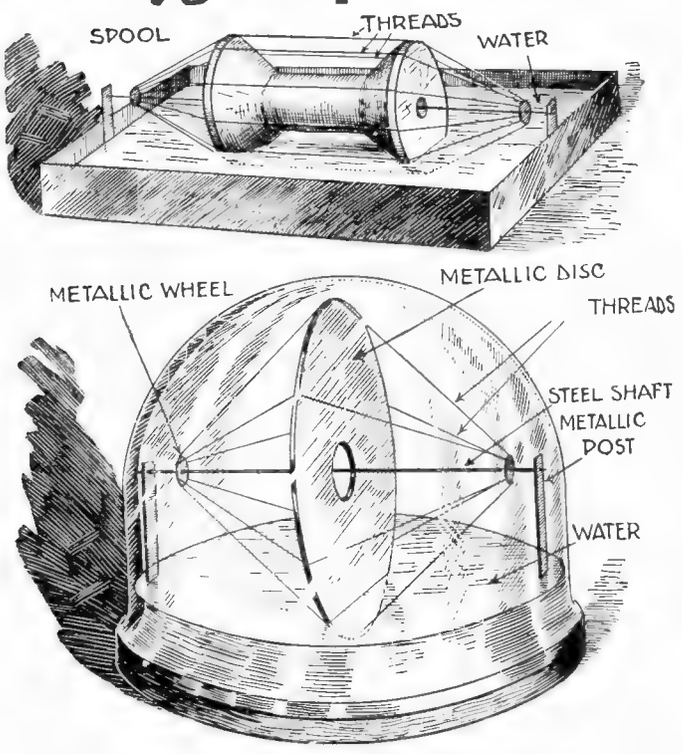
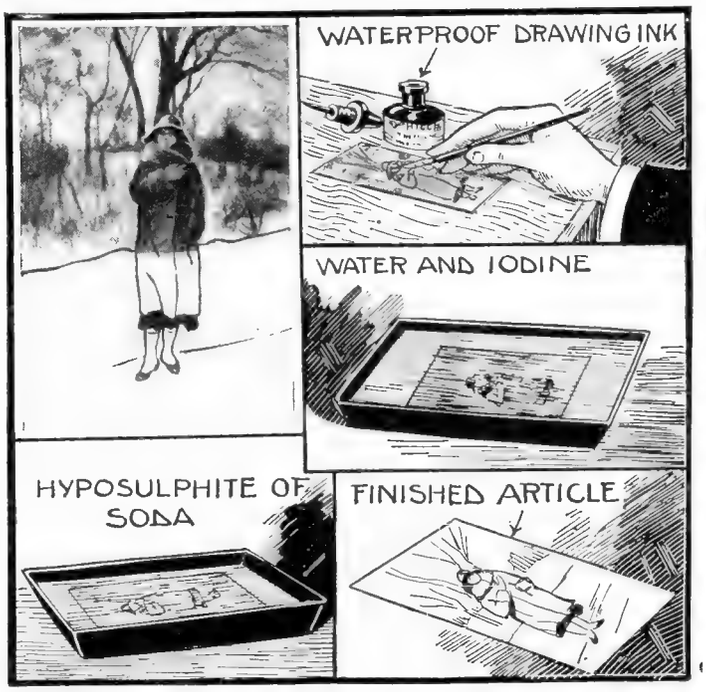
Hygroscopic Motor



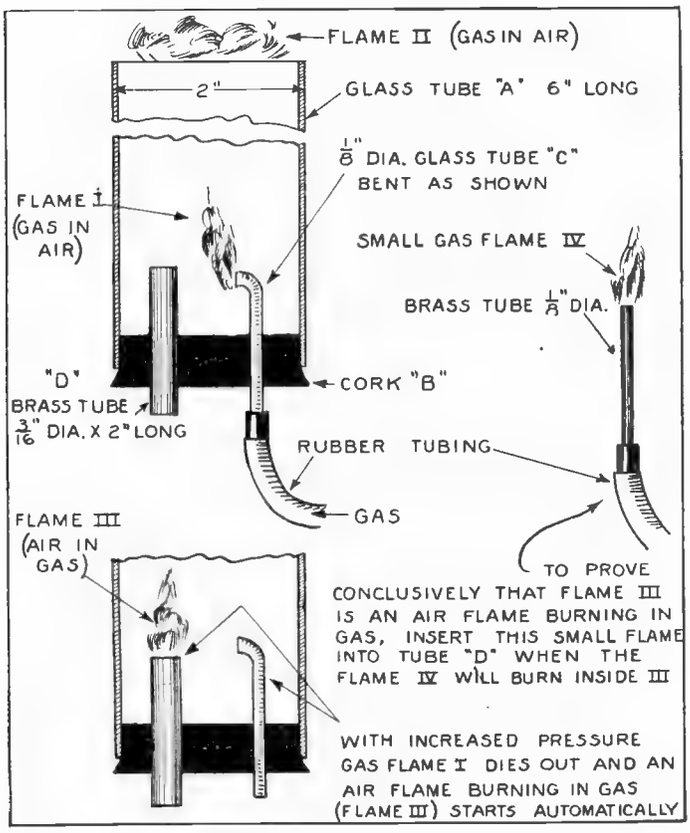
An interesting motor that will revolve without any visible external source of power is illustrated above. Two different types are shown. The uppermost can be quickly and easily made from a spool, several lengths of thread and a suitable wire axle. Assembled as shown, the wheel will turn about one revolution every 8 minutes. A more elaborate model may be made as shown in the lower part of the above illustration. —Emile Dion.

Shadow Pictures



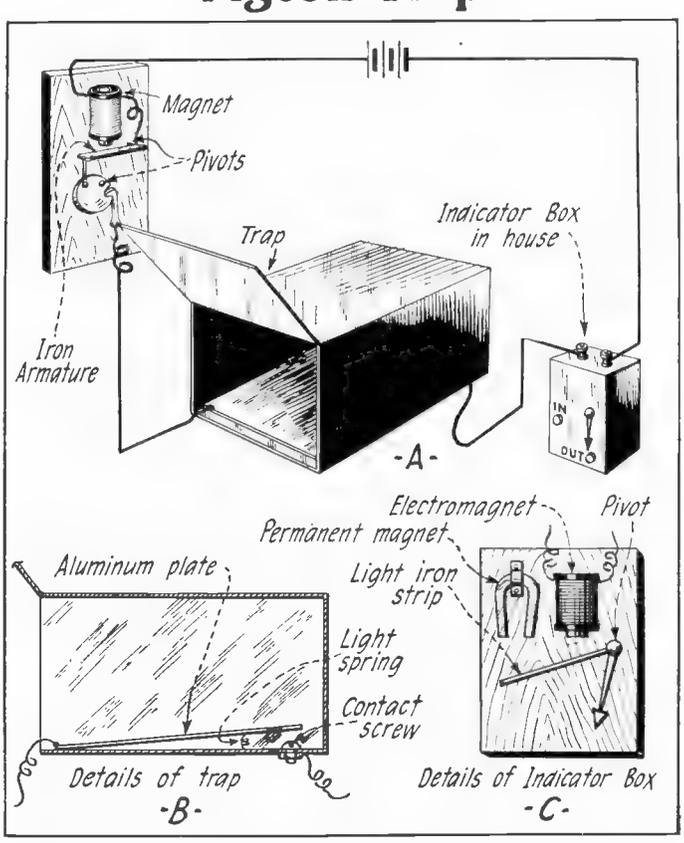
To produce shadow pictures, paint the shadows on a regular photograph heavily with ordinary water-proof drawing ink. A picture half prepared is shown in the upper left-hand corner. Then soak this prepared picture in a bath of water and iodine of a blood color until the back of the picture starts to become slate blue in color. Wash the print and soak in a strong solution of sodium hyposulphite (hypo). Dry the prints either in the ordinary manner or squeegee them on a standard sheet of ferrotype metal. A pleasing shadow picture such as illustrated will result. —M. C. Everett.

An Air Flame


FLAME II (GAS IN AIR)
2"
GLASS TUBE "A" 6" LONG
1/8" DIA. GLASS TUBE "C" BENT AS SHOWN
FLAME I (GAS IN AIR)
SMALL GAS FLAME IV
BRASS TUBE 1/8" DIA.
"D" BRASS TUBE 3/16" DIA. X 2" LONG
CORK "B"
RUBBER TUBING
GAS
FLAME III (AIR IN GAS)
TO PROVE CONCLUSIVELY THAT FLAME III IS AN AIR FLAME BURNING IN GAS, INSERT THIS SMALL FLAME INTO TUBE "D" WHEN THE FLAME IV WILL BURN INSIDE III
WITH INCREASED PRESSURE GAS FLAME I DIES OUT AND AN AIR FLAME BURNING IN GAS (FLAME III) STARTS AUTOMATICALLY

We know that a gas flame burns in air but will an air flame also burn in gas? This experiment answers the question. The apparatus necessary is shown. Connect the glass tube to the gas supply. Open the gas valve slightly and light. As long as the flame is small it will burn, but if turned on full, the flame will die out. At the same moment an air flame will form automatically on tube D and we can light another gas flame II at the top of the large glass tube. —C. A. Oldroyd.

Pigeon Trap



A pigeon trap that will not only catch and hold the bird but will also announce that a capture has been made is illustrated above. A bird entering the trap closes the contacts which sends the current through the indicator box and through the electro-magnet release. The door, which is heavy enough to hold itself closed, then falls and at the same time the indicator, detailed at C, shows that the trap has been sprung. Upon resetting the trap, reset the indicator by hand. —John Kautzner.

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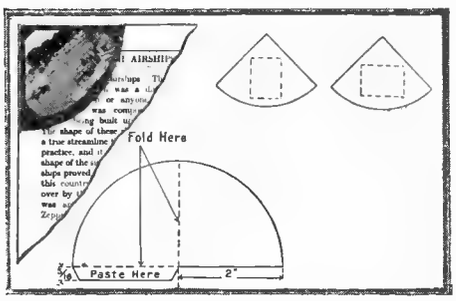
HOW TO MAKE IT

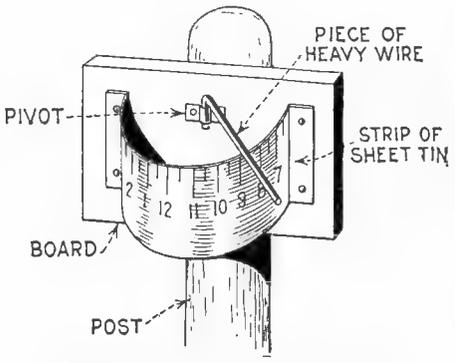
Book Marker



A novel book marker may be made by cutting a semi-circle with a small tab attached from heavy paper or thin cardboard. The exact shape and dimensions are shown above. The semi-circle is folded over and the tab pasted to its adjacent edge. The book mark is used as shown and can be decorated by pasting a photograph on it or by making a sketch in pen and ink.

—T. B. Marsden, Jr.

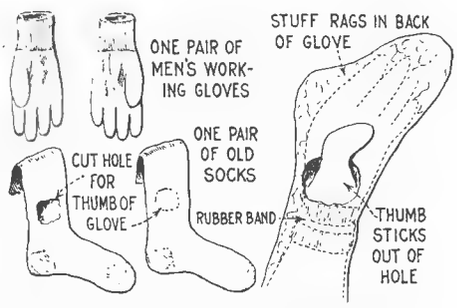
Sun Clock



The details of a unique sun clock are shown above. To read the time, the wire arm is swung until its shadow assumes a vertical position. The correct time is indicated by the shadow as at only one point on the dial will the shadow be vertical at a given time. The figures are inscribed on the dial by setting the sun clock each hour by a watch. In this way the clock is made quite accurate.

—Francis O. Boyd.

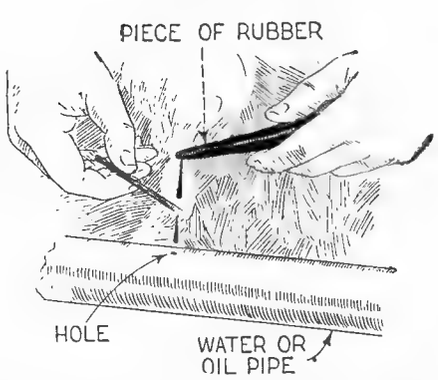
Boxing Gloves


ONE PAIR OF MEN'S WORKING GLOVES
STUFF RAGS IN BACK OF GLOVE
ONE PAIR OF OLD SOCKS
CUT HOLE FOR THUMB OF GLOVE
RUBBER BAND
THUMB STICKS OUT OF HOLE

A pair of cheap boxing gloves can be made from a pair of cotton working gloves and an old pair of socks cut short and with holes cut for the thumb of the wearer. The space between the glove and the sock is filled with rags or cotton. A rubber band is placed around the wrist over the glove and another one in about the same position, but over the sock. These retain the finished boxing gloves on the hands.

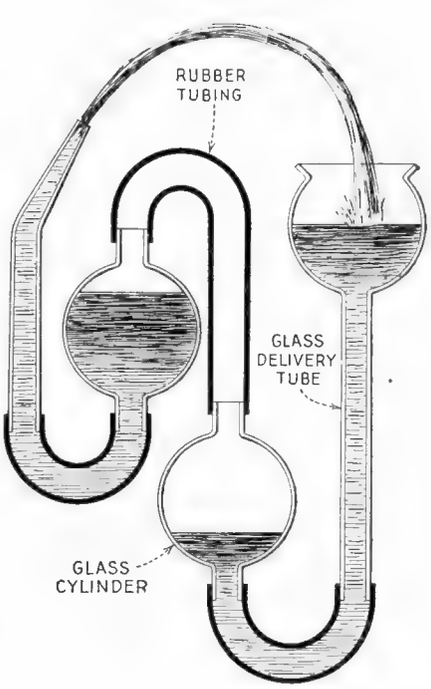
—Walter Schwartzmiller.

Pipe Repair



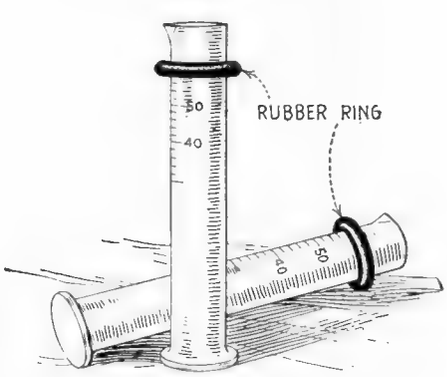
A small hole in a water or oil pipe of an automobile can be temporarily mended by melting a piece of rubber over it and allowing the drops to fall over the hole. Make a permanent repair as soon as possible as the rubber will not last. —Donald Bowie, Jr., Rep. No. 22261.

Hero's Fountain



A simple model of that most interesting demonstration apparatus known as Hero's Fountain may be made as shown above. A glass delivery tube, 3 pieces of rubber tubing, 2 glass bulbs and a nozzle are all the apparatus required. Assemble them as shown, placing the parts at the various relative heights indicated. Pour water into the delivery tube until the entire system is full. The water will then flow from the nozzle and if the latter is properly directed, will fall into the delivery tube as shown. The length of flow depends upon the constriction at the nozzle. Some of these fountains have been known to flow for 12 hours without stopping. —A. A. Blumenfeld.

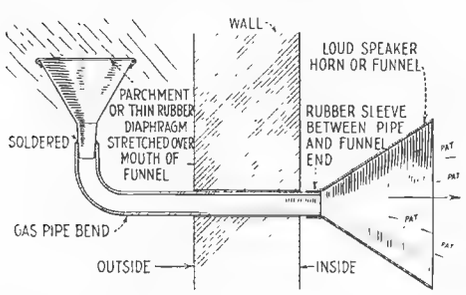
Graduate Protector



If a rubber ring such as used on suction flasks is placed around a graduate as shown above, it will prevent breakage. If the graduate falls on its side, the rubber ring absorbs the shock.

—A. Eidman.

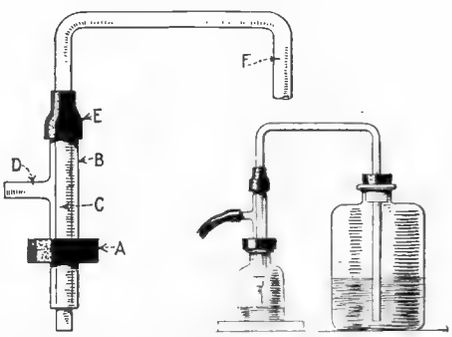
Rain Alarm



A rain alarm that requires no batteries or moving parts is detailed above. Two funnels, a diaphragm and a bent gas pipe are all that are required. The rain falling on the diaphragm produces sounds that are plainly audible at quite a distance from the reproducing funnel. The rubber sleeve facilitates removal.

—C. O. Oldroyd, Rep. No. 4433.

Bottle Filler



When handling liquids having disagreeable fumes, the above device is useful. Attach D to a suction pump. A partial vacuum is created in the bottle being filled and the liquid from the large bottle passes into the small one through the long bent tube.

—Author please send address.

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Readers Forum

SCIENCE AND INVENTION desires to hear from its readers. It solicits comments of general scientific interest, and will appreciate opinions on science subjects. The arguments pro and con will be aired on this page. This magazine also relishes criticisms, and will present them in both palatable and unpalatable forms. So if you have anything to say, this is the place to say it. Please limit your letters to 500 words and address your letters to Editor—The Readers Forum, c/o Science and Invention Magazine, 53 Park Place, New York City.

TELEPATHY

Editor, SCIENCE AND INVENTION:

I read your excellent magazine, SCIENCE AND INVENTION, with a great deal of pleasure, and also note your offer "to pay $1,000.00 to anyone who will prove telepathy." The following may be a proof, at least it would seem so to me.

About three years ago, on a Sunday, while residing here in San Jose, California, and during the month of September, I was just getting ready to leave my home and go out to my office, located on the same plot of ground as my home. I usually spend most of my time at the office. My wife then made the following statement to me: "Can't you stay in the house? Why do you always go to the office? I never see you. Take your typewriter and bring it here and do your work here." Accordingly, I went out and got my typewriter and brought it back from the office to my home.

At about 4 o'clock, while busy forming a business letter, I suddenly stopped writing. Everything was quiet about me. Sitting at the table with me were my wife and a 16-year-old daughter. I looked up in a southwest direction and saw my oldest daughter, seemingly 70 to 75 miles away, near a town called Salinas. She was riding in a two-passenger cut-down Ford. In front of her was another machine occupied by a young couple I knew, but I had no idea that my daughter was accompanying the other couple. Ahead of the first machine was a five-passenger Ford slowing down and getting ready to make a sharp turn. I then saw in my vision the car containing my daughter and the car ahead collide with the machine making the turn. In a trice they were piled up on the road. In the vision, I saw my son-in-law start for the small town of Salinas to get help, and with this view the image faded.

Now, sir, remember I didn't know that my daughter was going to motor toward Salinas. I didn't know that she was to accompany another couple. At 10 P. M. that evening my daughter came home. She went directly to her mother and told her the story. She had just gotten into the tale when I interrupted her, saying that it took place near Salinas at 4 o'clock. Abruptly she turned to me and asked me how I knew. At the same time the young man, now my son-in-law, contradicted me and stated that the event took place at 5 o'clock. I then related the vision to him.

Monday night, while gathered around the table, the young man contradicted his previous statement and told me that the event actually took place the way I described it. I then tried to explain, and this was my theory:

Radio activity and electricity have always existed. Extreme intelligence is the origin of radio as well as electricity. That part of mind acting through my daughter's mind when the so-called accident took place while she was away from home, saw through her eyes the occurrence. This was flashed through space unconscious to her and I caught it with my mechanism, the wonderful brain which was actuated by the radio activity. This theory is not new. Those in the East possess that faculty of transmitting thought waves, whereas those in the New World have seemingly lost it, or are insensitive to the vibrations.

This is my own explanation of the so-called mystery, in the olden days called telepathy, now called radio activity. But here is a little further explanation. In order to see it, the animal matter in which I am dressed and was dressed when the accident took place, is only the flesh. But that is not me, the ego, self-personality, or whatever you may care to call it. The ego only used the material body in playing his role in the drama of life. Distance is nothing. I can't produce this state of telepathy at will, but it has taught me that, under proper conditions, such a thing can and does take place.

I will be glad to have your objections and a check for $1,000.00.

C. J. CHRISTIANSON,
Formerly Pastor Swedish Baptist Church,
San Jose, Calif.

(The conditions of our contest call for the production of telepathy under test conditions. Mere statements of telepathy having taken place cannot be entered into the contest. If you are, therefore, prepared to produce telepathy under test conditions, and simple effects only would be asked, we would be glad to have you enter our contest. Needless to say, in spite of the many individuals calling themselves mind readers, not a one has appeared to make such a simple test as for instance, reading a five-letter sentence which somebody else may care to write on a slip of paper, seal and place in his pocket while a thin partition separates the telepathist and the writer.

The theory which you have evolved is hardly plausible. Radio activity, as we know the term, is a recognized fact. Telepathy is not.—EDITOR.)

A PREDICTION

Editor, SCIENCE AND INVENTION:

Here comes an old reader of SCIENCE AND INVENTION as well as *Practical Electrics* now called *The Experimenter*, who would call your attention to the fact that there are some folks who know and are able to predict events, referring to pages 905 and 940 of SCIENCE AND INVENTION, January issue, current year.

I predict that there will be war in Europe before the trees have put on their green garments, which means before the middle of the month of May. This war will be a general European war. This war will establish peace and tranquility in Europe.

(*A subsequent letter reads as follows*:)

In response to SCIENCE AND INVENTION, I make the following further predictions in regard to this coming war.

First, that the Russians and the Germans will wear the same color and style of uniform when the war is in full swing. Second, this coming

war will be the means of ending Bolshevism, and Russia will again be imperial, even before the war is over. Third, this coming war will bring about the end of the British Empire. It has been thus decreed by Him who still rules Heaven and Earth. All help and assistance will prove futile.

CHARLES M. MAHR,
Bluffton, Ind.

(SCIENCE AND INVENTION *Magazine is offering a prize of* $1,000, *which is part of the* $11,000 *Psychical Prize Contest, to anyone who can accurately predict events of such a nature that they would have no control over the same. The writer of the letter above has made a prediction, and like all predictions of this nature, it is far from accurate. June 1st has arrived and passed. There is no general European war.*

Now it would have been a simple matter for anyone to make a prediction of this nature, considering the fact that Von Hindenburg took the office of presidency over the German Republic. Von Hindenburg is disliked by German socialistic factions. On this basis, one could predict a war in Germany with the chances about even that such a civil strife would occur, provided of course that the individual making the prediction would not know much about the internal affairs of the German Republic. We do not believe that such a war will occur. We sincerely hope and trust that such a condition will not arise in Germany now, as they are making rapid strides for better social conditions, and rapidly coming forth into the commercial field again.—EDITOR.)

DO THE BLIND DREAM?

Editor, SCIENCE AND INVENTION:

I would like to have you answer this question in your Readers Forum department. Can a person born blind visualize images of things in his sleep?

HAROLD MATTHEWS,
Martinsburg, Mo.

(Yes, a blind person visualizes images in his sleep. If the person has not been born blind, he often visualizes images and objects which seem to him to be concrete, and which seem identical with those objects he had known and seen during the days when his eyesight was not impaired. Even those blind persons afflicted since birth often visualize things in their sleep and dream about objects which seem to them real, and which they seem to actually see. These objects are not always correct in detail with those which the seeing person knows. If we permit a blind person to feel an object, and then describe it, his description may be erroneous, because he was unable to associate in his mind its shape unless that shape were simple. He is likely to dream of that object as he thinks it appeared to him.

Some blind people, when they dream, only seemingly make use of those senses during their dreams over which they have control, and they may dream of feeling an object, smelling it or tasting it, but rarely visualize that object.—EDITOR.)

DOESN'T LIKE OUR FICTION!

Editor, SCIENCE AND INVENTION:

I have read your magazine since the August, 1923, issue, containing "The Man From the Atom," "Around the Universe," and other very interesting stories and articles, but it has become less interesting—to me, anyway.

Why can't you give science more room in your pages? There are plenty of magazines in existence that tell how to make butterfly nets out of broken knives, but it is hard to find one that tells much of science. I beg you to consider whether or not you give too much room to mechanics.

Also, your scientific stories have become less scientific than those I mentioned; I think that you will admit that that is true of such stories as "The Man From the Meteor." Why can't your stories be scientifically probable, rather than merely—and barely—possible?

But I am now in a hurry, and my typewriting ability is obviously poor, and I am excited, as I always am when I think of such stories as that of the gentleman on the meteor. Won't you consider what I have said, and, oh, yes, won't you tell the author of "The Living Death" that to make a description horrify he must use subtler means than stating the thing described is horrible? And that such words as "'tis" are unusual and, consequently, they intrude upon the idea presented. "The Infinite Vision" was a fine story.

CHESTER GRIFFIN,
Galveston, Texas.

(We should, of course, comment on this letter, but we will reserve that right and let our readers answer Mr. Griffin.—EDITOR.)

ELECTRICITY IN PLANT GROWTH

Editor, SCIENCE AND INVENTION:

I have been a reader of your magazine ever since it was first published, and have missed very few issues. It is needless to say that I am pleased with it. The thing I like most about it is that it deals with almost everything. There is one thing that it does not deal with, and that is scientific raising of flowers or vegetables. Things that a man could use in his back yard. I don't refer to ordinary knowledge of agriculture, but scientific knowledge of habits of plants.

Some readers might suggest that one interested in plants might buy magazines on the subject, but such magazines contain very little that is of value. Then, again, many readers of SCIENCE AND INVENTION, and similar magazines, do not read any other publication.

But most readers have a little back-yard garden. I have been experimenting this year with forcing dahlia growth by high frequency currents collected by radio antennae. The experiment is not completed, but others may be interested in it. Real professional plant growing is practically scientific.

I would like to hear through the Readers' Forum what others think of the suggestion.

L. RINGER,
Cincinnati, Ohio.

(When any radical advance in horticulture is made, we always report about it. We have published articles on the construction of apparatus for stimulating plant growth by high frequency currents artificially produced, and also illustrated the method outlined by you, which is now a rather old system. We will continue to advise of the more important developments in this field.—EDITOR.)

APPROVAL

Editor, SCIENCE AND INVENTION:

Just a word or two to show my appreciation of the articles in two of your magazines, SCIENCE AND INVENTION and THE EXPERIMENTER. I have been getting the same for three years, although I am only 14 years of age. I have always been interested in science, but chemistry is my favorite. One of the many merits of your magazines are the excellent chemical articles, and I hope they will always be as good as at present.

JAMES H. BLACK,
Johnstown, Pa.

(We thank you very much for your kind compliments and are glad that you like the magazines. We trust we shall always please you.—EDITOR.)

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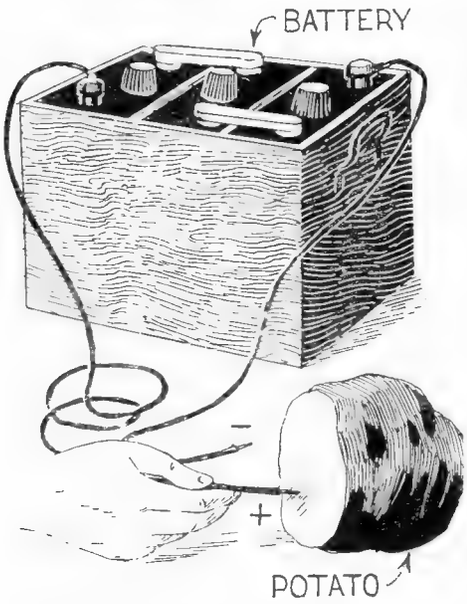
WRINKLES
RECIPES & FORMULAS

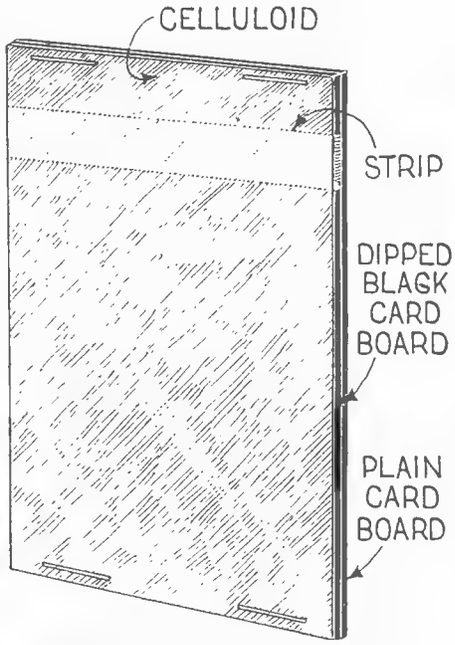
Edited by S. Gernsback

Pole Indicator



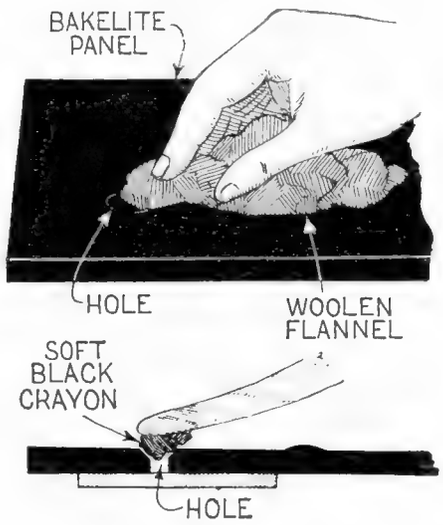
Often when a storage battery is to be used in some circuit, where polarity is an important factor in the final results, a satisfactory type of polarity indicator is not at hand and the marks on the battery are so indistinct as to be undecipherable. In such an event, cut a potato in half as above and thrust two wires that are connected to the battery into the potato. The positive wire will turn the potato green.—F. J. Wilhelm.

Memo Pad



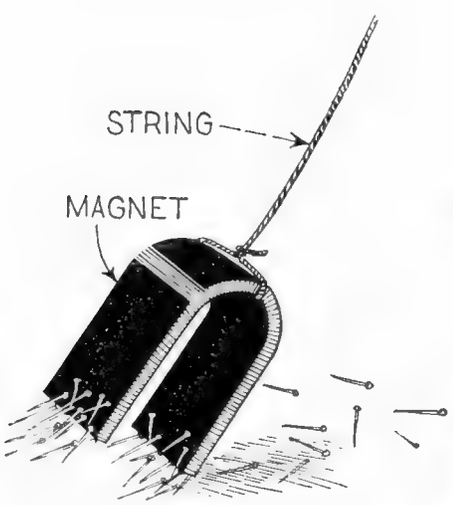
To make an everlasting memo pad, bind a strip of celluloid, a strip of prepared cardboard and one of plain cardboard together as above. Place an endless strip of paper around the prepared card so that it can be moved up and down. The prepared card is black cardboard dipped in paraffin. Writing on celluloid with pencil is erased by pulling the endless strip across the surface of the prepared strip.—Leo Preston.

Panel Repair



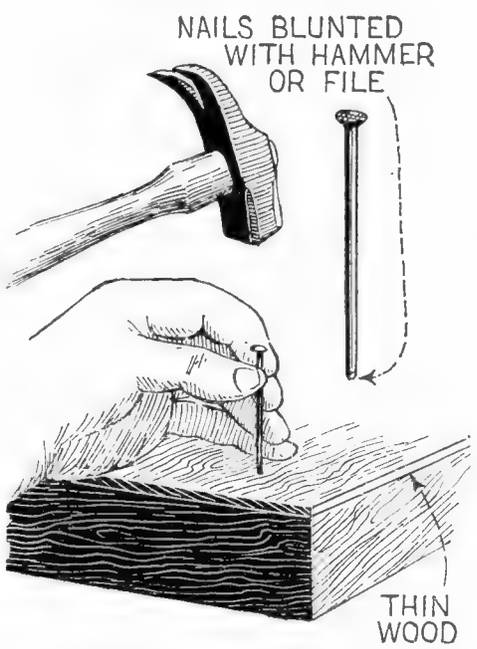
Often it is desired to use an old panel on a new set or for some other purpose but the holes drilled in the surface mar the appearance. These, however, can be easily filled up by pressing a small quantity of soft black crayon into the hole and then rubbing off the surface with a piece of woolen flannel as shown. When plugging the hole, a strip of glass should be placed under it so as to prevent the crayon from working out. In this way a smooth surface can be restored to a panel with little trouble and practically at no expense. Use mixed black and yellow wax for mahogany colored panels.—Wilton F. Swatch.

Magnetic Broom



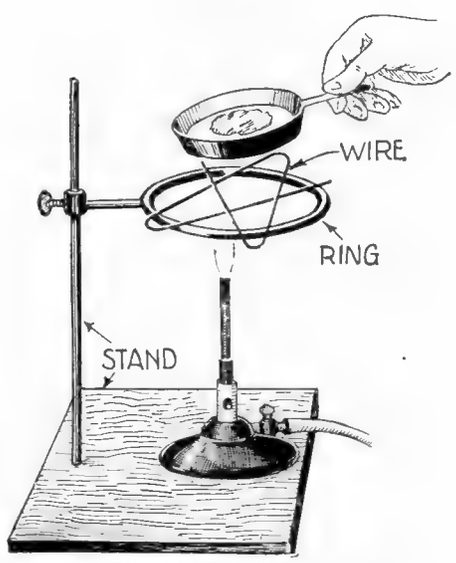
When a quantity of nails or other small iron or steel objects are spilled on the floor, they can easily be picked up by means of a magnet suspended on a string as shown above. The magnet is drawn across the floor several times and when picked up will be found to bring all of the magnetic objects with it. In this way, a job that was formerly tedious can be performed with little effort and in a small fraction of the former time.—E. L. Dunbar.

Nailing Thin Wood



To avoid splitting thin wood, hammer or file the ends of the nails to a wedge shape and drive the nails so that the wedge-shaped point crosses the fibers. Much splitting of thin wood will thus be eliminated.—Max Ruschmann.

Ring Stand



In the chemical laboratory, often large ring stands only are available. To support small evaporating dishes or other apparatus on them, bend a piece of wire into the shape shown above and support the receptacle thereon. In some cases, two large wire hairpins can be laid across the ring, with the same results. This kink is one worth bearing in mind as it will often come in handy.—Jesse Walters.

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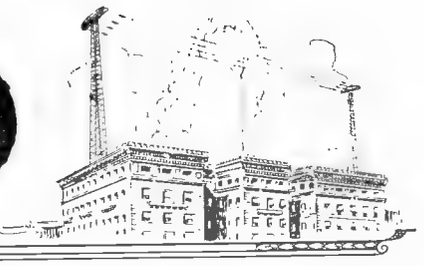
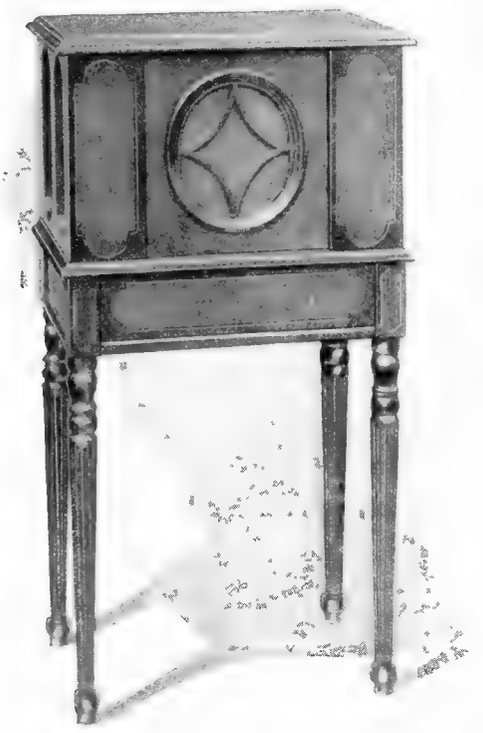
RADIO



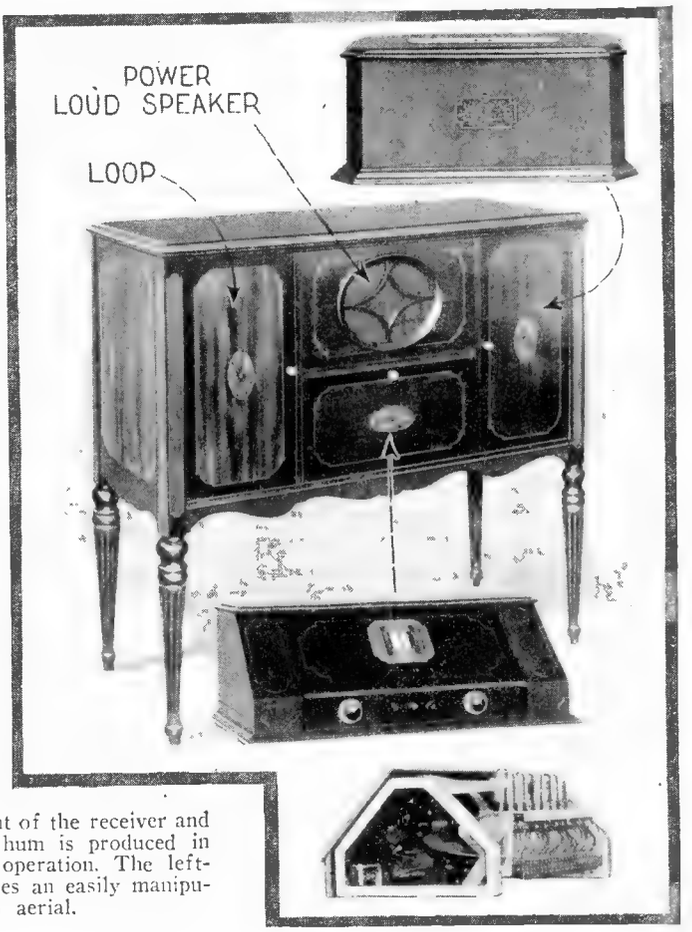
New Power Speaker and Super-Heterodyne on A. C.

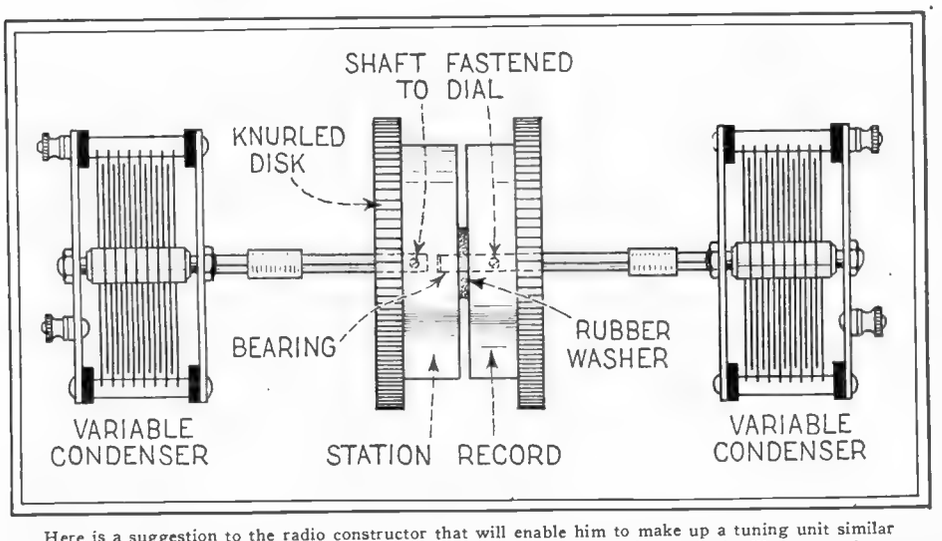
By L. PORT



This new power speaker that is operated on alternating current is manufactured with a small table as above for use with any radio set and also is incorporated in various other large elaborate models of complete receivers. The above view shows the speaker ready for use. A specially designed amplifying unit enables this speaker to reproduce great volume with absolute fidelity.

THE photographs at the right illustrate a new type of Super-Heterodyne receiver that is absolutely self-contained. It requires no battery for its operation and all that it is necessary to do is to plug in on the 110 volt A.C. lighting circuit and manipulate the set. The receiving set proper is mounted in back of a folding door which can be let down, exposing the controls and at the same time furnishing a writing desk. The type of 8-tube Super-Heterodyne receiver used in this impressive piece of furniture is shown directly below the cabinet. Front and rear views of the set are shown. The unit that furnishes both "A," "B" and "C" supplies is shown in the upper righthand corner. Using a tube rectifier, it furnishes a remarkably smooth current for all purposes. This unit is placed in a compartment to the right of the receiver and is so shielded that no hum is produced in the set when it is in operation. The left-hand compartment houses an easily manipulated loop aerial.





Here is a suggestion to the radio constructor that will enable him to make up a tuning unit similar to that used in this new Super-Heterodyne receiver. Variations of this method will suggest themselves. The condensers are mounted with the plates at right angles to the panel and the shafts are connected to the two dials protruding through the panel.

IN the 8-tube set shown above, an exceedingly simple method of control is employed Two knurled disks, to which station log disks are fastened, protrude through the cabinet and are so constructed that when one is turned, the other will follow it. However, by holding one dial with the fingers of one hand so that it cannot turn, and moving the other one with a light pressure, fine tuning can be obtained and slight discrepancies in the tuning of the set, that will not allow one-dial control, can be corrected. This system can be obtained by the method shown at the left. The rubber washer allows the two dials to turn together but also allows one of them to be stopped.

This instrument possesses unusual operating features, as well as quality and volume. This instrument evoked prolonged applause when exhibited in operation at a recent dinner given in New York City to radio editors and engineers. It has a trans-continental range under good operating conditions. The tremendous volume obtained with the new loud speaker corresponds to that of a small orchestra.—*Photos Courtesy Radio Corporation of America.*

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WRNY Plan Expands

By Charles D. Isaacson, Program Director

AS I write this, we are on the eve of our WRNY Artists' Supper. Let me explain what that means. We will meet in the Grand Ballroom of the Hotel Roosevelt, which is our headquarters. It will be the first time that all the artists who give the programs at our station will be together. It will be, I think, one of the most motley crowds ever assembled. There will be ministers, priests, rabbis, chefs, food experts, dieticians, grand opera singers, light opera singers, actors, actresses, violinists, pianists, dancers, physical culture experts, jazz players, ukulele players, American Indian princesses, cornetists, pipe organists, architects, sculptors, painters, poets, novelists, authors, philosophers, radio authorities, editors, children's fairy tale authors, aviators, automobile manufacturers, finance experts, lawyers, designers, photographers, doctors and labor experts.

This general "get-together" will be as dramatic an explanation of the WRNY plan as anything we can say, and so we are going to take flashlights that night for you to see, and broadcast the merriment for you to hear. We will have a roll call, the like of which has never been presented on stage or screen, for everyone, in response to his name, will have something to say or do by way of entertainment.

We have just finished counting the list of people who belong to the WRNY Company; there are over 700, but only the principals will be present at the dinner. By this, I mean that we shall have the heads of the departments, the soloists and the chief speakers only. Members of the chorus and musicians in the orchestras and bands will not be on hand, but will be represented by their chiefs and directors.

THE RADIO THEATRE PLAYERS

Since last month, much has happened. One of these is the organization of the "Radio Theatre Players," an organization of professional actors and actresses under the direction of Mr. Alfred Rigali. Each member of the cast has been leading lady or leading man in some production or stock company, or touring dramatic company. The cast is as follows: Madaline Hunt, Maisie Cecil Klark, Ruthelma Stevens, Edna Marshall, George V. Dill, Gladys Pabst, Santos Ortega, Herbert MacDonald, Alfred L. Rigali, Harry Mervis. There is also a second dramatic stock company which has organized, and next month we will tell you more about that.

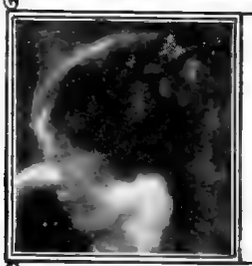
By the way, practically all big events at WRNY work in duplicate, since it is easier to have two companies to do one performance than for one company to do two performances. Thus, you will find that Clementi de Macchi alternates with the Remo Taverna Opera Company. The cast of the de Macchi Opera Company includes Cornelia Zuccari, Edna Estwald, Sophie Reznick, Dorothy Edward, John Fobert, John Argentino and Mae Gertwin.

The Taverna Opera Company is composed of Hortense Dorvalle, Adelaide Vilma, Teresa Demarchis, Vincent Carelli, Giovanni Lombardo, Luigi Dalle Molle, Louise Vermont. Then we have also other grand

Harriet A. Seymour, founder of the Seymour School of Musical Re-education and a well-known musical author.

I. Lonka, ballet mistress, from whom many interesting talks may be expected.

Bernece Kazounoff, who will give piano recitals of interest to all music lovers.



Florence Geringer, jazz piano queen who will be heard from WRNY every other Monday evening.

Merryle Stanley Rukeyser, an authority on finance, speaks at WRNY every other Wednesday.

Matthew Woll, Vice-President of the American Federation of Labor, talks once each month on Labor—Capital.

Chef Roger Cretaux, of the Roosevelt, who gives "Eating Chats" every Thursday evening.

Harvey Wiley Corbett, well-known architect, who talks on "Great Buildings" every Wednesday.

Baroness Leja de Torinoff, writer, lecturer and singer, who will conduct a novel fiction service.

Sascha Fidelman, first violin of the N. Y. Orientalle, which renders musicales every Sunday.

Louis Aschenfelder will be one of the features every Friday evening in an "opera duet."

Frederick Hulsmann will talk on the care of your body every Sunday afternoon.

Joseph Pavloff, who will present the "Ballade Minstreal" every other Thursday evening.

J. Van Cleft Cooper, who, with his Russian Cossacks, broadcasts musical travelogues every Monday.

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Gennaro Mario Curci, assisted by many other musical artists, will entertain every other Wednesday.

Director Taverna, whose operetta will be presented through WRNY every other Friday evening.

opera units: Mr. Louis Aschenfelder, who is concentrating on French music, has the group to aid him which includes Marian Cornwell, Arthur Riehl and Louise Keller. Another excellent grand opera company is that of Leo Braun. He has a splendid cast: Franklin Riter, Waldemar Rieck, Fred Shaer, Siegfred Philip, Palmira Felici, Sybil Van Wezel, Frances Golden, Helen Braun and Isabelle Wood.

In light opera, Gordon Hampson and Mme. Andres Parker alternate. The personnel of Gordon Hampson's company includes Charlotte Roze, George Brandt, Rita Sebastian, Pierre Remington and Eleanor Rogers. Mme. Parker's company consists of Lou Ellen Remmy, Paul Largy, Ann Ermet, Vera Grace Perry, Miss Schwei, Sara Sampson and Chad Parker.

In the interpretation of great song literature, we have some extraordinary combinations—Dr. Sigmund Spaeth's Ampico artists, for instance. These artists have, so far, included John Tasker Howard, Wallace Cox, Frederic Dixon, Stuart Ross and Adam Carroll. Gennaro Mario Curci, best known as the brother-in-law and coach of Amelita Galli-Curci, leads another group. Then we have the Meta Christensen Quartette, directed by Elmer Zoller.

You have probably already heard "The Love Song Girl," Lorna Lea; "The Lullaby Lady," Kathryn Behnke; "The Ballade Minstrel," Joseph Pavloff, and "The Poet-Peasant," Rose Dreeben. But have you heard "Svanhilde," the Swedish singer, or Francine Vyde, our unusual coloratura soprano, or have you, by any chance, yet noticed the work of Louise Vermont, who is presenting "Moods in Song"? Many are there who have enjoyed the popular "Old-Time Songs" by Anna Russo, and Englishmen everywhere have listened to James Gordon Beaver.

WRNY'S ORCHESTRAS

There is Ben Bernie's Orchestra, Orlando's Roosevelt Concert Orchestra, Jimmy Lent's Stellar Orchestra and Ferrucci's Orchestra, playing the "Evolution of Jazz."

There is no finer ensemble in America than the New York Quintette, which is composed of Mark Gunzburg, Sascha Fidelman, Bernard Ochs, Samuel Stillman and E. Ligas Shuk. Chamber music is well handled by Rose Becker and the Sadrian, Volga and Bernstein Trios.

In the piano department, we have Bernice Kazanouff and Margaret Hart, who give two-piano recitals, and such soloists as Rita Maginott, Tilly Sper, Iris Brussels, Alex Chigrinsky and Charles Haubiel. J. Van Cleft Cooper carries us "Around the World in Music"; in the violin department, we have Paul Bernard and the Rudolf Larsen Violin Ensemble, and so it goes, through all the instruments.

Anita Browne is in charge of literature, poetry, fiction and philosophy.

The theatre department is one of the most interesting which we have. *Theatre Magazine* is in charge of the chats which give the gossip of the theatre.

The New York *Telegraph* has charge not only of the theatre news but also of the sports. Their sport flashes, unexcelled in radio, give last-minute news in all branches of sport. The *Telegraph* is presenting "Up and Down Broadway," which has proved extremely popular.

Have you heard anything about the Little Theatre contest and the fact that Mrs. Brock Pemberton, who designed the costumes for "The Green Hat," is doing a series here called "Costumes of the Theatre," and that Resta Crowell is presenting a series called "Theatre Classics"?

THE ARTS

Harvey Wiley Corbett, who designed the Bush Terminal at 42nd Street and the memorial to Washington and Alexandria, will discuss architecture.

Alexandre Zeitlin, one of the foremost modern sculptors, discusses the art of sculpture weekly at our station.

Celeanor Dugas, of the painting series, tells of the great painters of the past and present, and Mrs. Rose Berry, who is the head of the Art Department of the Federated Women's Club, appears regularly.

Speaking of women, WRNY has recently inaugurated a Woman's Hour. Nestor Matson will give exercises for reducing, Dr. Harry Finkel will speak on "Diet," Dr. Siegfried Block on "Health," Mrs. Berry on "Arts" and Mrs. Mary F. Roberts, of *Arts and Decorations*, discusses interior decoration, and *Pictorial Review*, through its editors, appears regularly once a week.

We are particularly fortunate in being able to announce that some of the editors of *Life*, Charles Dana Gibson, Robert Benchley, Foster Ware, Henry William Hanemann and Robert B. Sherwood, as well as many other illustrators and feature writers, will appear regularly at WRNY. And let us not forget that the greatest food expert in America, Alfred McCann, will give "Food Talks," and that Chef Cretaux discusses the culinary arts each week.

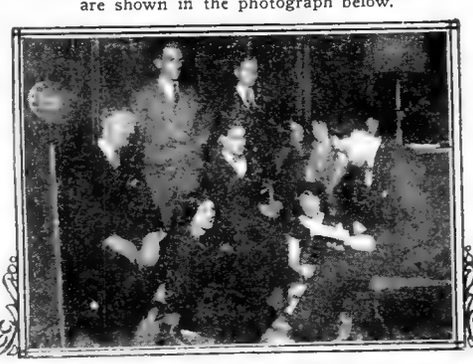
The children are not forgotten, for Gregory Hartswick tells fairy tales, and we have Rita's Kiddy Parties, and Lonka's Kiddy Dances.

In the educational groups we have Major Dent Atkinson, who takes charge of the geography period.

For finance, we have Mr. M. Ruckuyser, author of "Common Sense of Investment" and editor of the financial column of the New York *American*.

In law, we have Charles A. Vilas, who handled the famous Consolidated Gas suit. We also have speakers from the Constitution League and Women Lawyers' Association, and every candidate of political importance is appearing or will appear at this station.

The Radio Theatre Players, a dramatic stock company whose presentations will interest all, are shown in the photograph below.



Anne Russo, whose specialty is old-time songs, is sure to be most interesting every time she appears before the microphone.

Meta Christensen, leader of a quartette which can be heard at WRNY every other Wednesday evening at 9:45 o'clock.

In aviation, we have associated with WRNY the American Society for the Promotion of Aviation.

The Religious Department is in the hands of Dr. Christian F. Reisner, and the Jewish Circle is directed by Dr. Isaac Landman.

Matthew Woll, Vice-President of the American Federation of Labor, discusses economic problems.

Frederic Hulsmann is in charge of the Physical Culture Department.

Have I left some things out? Perhaps I have, but I will tell you more next month.

MUSIC OF THE MONTH

The Sadrian Trio has been playing old-time music, which has included "Woodland," "Babes in Toyland," "Merry Widow," "Pink Lady," "Floradora," "The Chocolate Soldier," "Mme. Modiste," and "The Fortune Teller." Amongst old operas given have been an outline of "The Mikado," "Pirates of Penzance" and general selections by the Mme. Parker Singers and selections from "The Merry Widow" and others by the DeMacchi Opera Singers, also "Rigoletto," and general programs, and similar numbers in the Taverna group.

Grand opera has brought in the Aschenfelder series, giving selections from "Romeo and Juliette" and "Cavalleria Rusticana."

The Celtic Concert and Theatre Guild gave an interesting program of Irish music and poetry.

Guiseppi Adami, in his violin series, played selections by Monti, Sirori and Boccherini.

Anna Drittell, in her first appearance, played from Granados, Haydn and Saint-Saens.

Thelma Schiffman gave a general operatic program and sang selections by Amina, Bellini, Del Riego and Fritz Kreisler.

Lorna Lea, in her first appearance, chose Bemberg, Tosti, Dobson, Lohr and Spross.

The Volga Trio has been playing a series of "Around the World" concerts. England and France have been their first choice. They include favorite melodies, as well as music of the great composers. For instance, in the English music, they played "Banks of Allen Water," "Cherry Ripe," "Sailors' Horn-Pipe" and "Rule Britannia." Composers read in the English group were Tate and Sir Edgar Elgar.

One of the interesting novelties was the appearance of Sigmund Spaeth, creator of "The Barber Shop Ballads."

Francine Vyde, our coloratura singer, brought such numbers as "Caro Nome," "La Partida" and "Charment Oiseau." That was her first appearance. Another appearance included Proeh's variations and the

(*Continued on page 769*)

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One Tube Regenerative Interflex

A Remarkable Single Tube Receiver for "DX" Reception

By HUGO GERNSBACK

THE general trend of radio receiving set design today is toward receivers that can be made simple in control yet retain many other desirable features. Up to the present, attempts at single control receivers have usually resulted in decreased selectivity to such a great degree that the sets become valueless except for local reception. Other so called single control receivers have often incorporated other auxiliary controls than the main one, which make up for the discrepancies in the receiver and render the tuning sharp. The writer, however, has designed a set which is described here, which can truly be called a single control receiver and which is excellent for D.X. reception. For the purpose of balancing the set there are other variable constants but once these are placed in the correct positions for the tube and instruments used, the only part that must be varied is the tuning condenser, controlled by the large vernier dial on the panel. Thus, the set is controlled solely by the one dial, once the rest of the instruments are at their correct values.

In order to facilitate the tuning of this receiver, and to split up the stations on equal distances around the periphery of the dial, a straight line frequency variable condenser is employed. This type of instrument makes for much easier tuning, particularly on the shorter wave-lengths, if the tuning inductances are properly designed. In this particular case, all of the necessary constants are given in Fig. 4 and the complete construction of the coil is described below and shown in the illustrations.

In the various photographs, a specially designed coupler is shown, but the reader should have no trouble in duplicating it or in making some other kind that will work equally as well. For instance, experimental work with this set could be carried on by using a standard three-circuit coupler with the number of tickler turns cut down to the value shown in Fig. 4, approximately 25 turns. If, however, you wish to make your own coupler and to be sure of having everything correct, select a thin wall bakelite tube, 3 inches in diameter and near one end wind 8 turns of No. 22 D.C.C. wire. This constitutes the untuned or aperiodic primary. Starting about one-quarter of an inch above this winding, wind 46 turns of No. 22 D.C.C. wire, thus forming the secondary. Now, if you want to stick to the design used by the writer, and this is advisable, mount the tickler coil within the stator and use a coarsely threaded rod to vary its position. The rod can be fastened to the honeycomb coil by means of a disk, which will just fit within the hole in the center of the latter, and two guide rods can be arranged to prevent that coil from turning. Make flexible connections from the tickler coil to binding posts on the stator.

After you have connected up all of the instruments by following the diagram shown in Fig. 4, the set is ready to put into operation. The one shown in the photographs incorporated a filament control jack, which is just a little refinement, that can be added at your own discretion. Now connect all the batteries and place a tube in the socket. Light it to about normal brilliancy by turning the filament rheostat and then vary the tuning condenser. If absolutely nothing is heard, reverse the position of the crystal detector in the circuit. The set will probably oscillate but if it does not, turn the screw in the center of the small condenser, 4, until it does. Now turn this screw the opposite way very carefully until the set just stops oscillating. Tune in a station with the large variable condenser and when it is at maximum volume, adjust the filament rheostat for still better results. When this has been accomplished, a minute variation in the position of the adjusting screw of the small fixed condenser may be necessary in order to find the very best operating position. After all of this has been accomplished, the only variable characteristic that need be changed is the tuning dial itself. If, however, you change tubes or change crystal detectors, the small condenser, 4, and the rheostat, 13, must be readjusted for best results as described above.

After these adjustments have been made, it will be found that the tuning is extremely sharp. You will need a good vernier dial to get the best results. With careful manipulation, very good "DX" results can be easily obtained. On local stations the volume is much greater than the usual one tube set. Fair loud speaker results are usually had. For additional details see *"Radio News"* December issue.

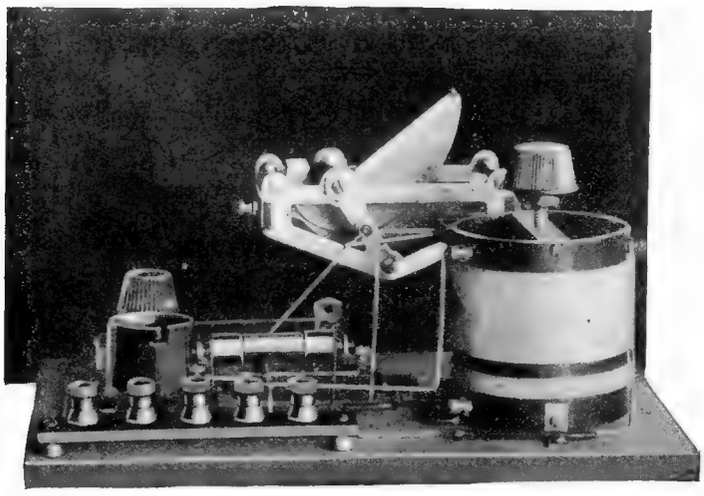

Fig. 1. A rear view of the simply designed single tube Interflex receiver, showing fixed crystal detector at right of tube socket.

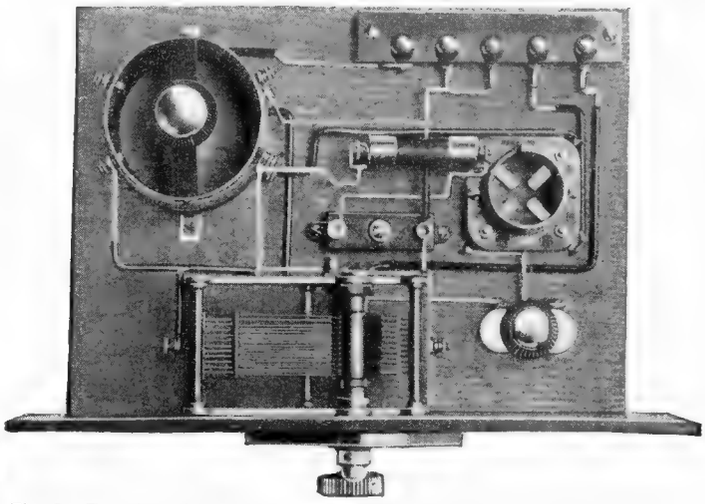

Fig. 2. Top view of receiver. Note balancing condenser directly below the fixed carborundum crystal detector of the cartridge type.

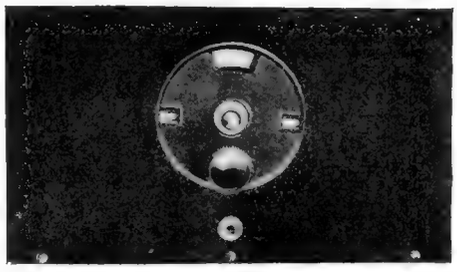

Fig. 3. The panel view of this receiver shows the extreme simplicity of tuning. Only a single tuning control is employed.

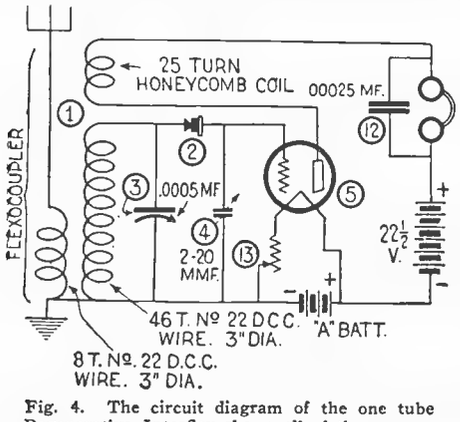

Fig. 4. The circuit diagram of the one tube Regenerative Interflex shows all of the connections for the various instrumenta used. A variable grid condenser can be placed at 4.

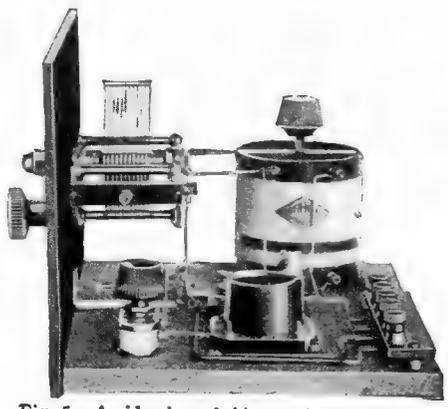

Fig. 5. A side view of this set shows the position of the filament rheostat placed directly in front of the tube socket and fastened to the baseboard. Special coupler is shown in this set.

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The Radio Constructor

How to Build a Complete Five- or Fifty-Watt Amateur Transmitter for Use on the Short Waves

By A. P. PECK, Assoc. I. R. E.

THE article appearing under the head of *The Radio Constructor* in the October issue of this magazine has occasioned so much interest that we have decided to present all of the necessary details for constructing a higher powered transmitter.

TRANSMITTING AERIALS

Many questions have arisen regarding the types of antennas that are suitable for radio transmission work. Today it is a generally accepted belief that a single wire aerial can be used for transmission with almost as good results as the multi-wire types. This is particularly true on the shorter waves such as the 80, 40 and 20 meter bands. The set that is described here is designed for use on the 40 meter band and, therefore, we will consider in particular an aerial and counterpoise system that will be suitable for such work. The aerial proper should not be over 35 feet long over all. This includes the lead-in down to the antenna binding post on the set. In some localities it is quite possible to use a vertical antenna of this length, although in other places a short flat top must be used. At one station, a flat top 20 feet long and a lead-in 15 feet long are used. The highest point of the aerial is 30 feet above the ground. The counterpoise is run about 3 feet above the ground and is as well insulated as the aerial. It has approximately the same dimensions as the latter. In other words, the lead from the counterpoise to the set is about 15 feet long and the part of the counterpoise that is parallel to the ground is about 20 feet long. From this data you can undoubtedly evolve an aerial that will suit your own particular locality and still will not be too long or too short for 40 meter work.

Fig. 1. A general view of the layout at the writer's station is shown in the photograph directly above. Note how the transmitter wave-length controls and the meters are always accessible and visible to the operator when he is seated in front of the receiver. The switch for turning on the current to the transmitter and the key for sending out the signals are located at 23 and 21, respectively. They are close to the operator's right hand at all times.

GENERAL ARRANGEMENT

Before going into the actual construction of this radio transmitting set, let us consider for a few moments the general arrangement of a station equipped for transmission. It is preferable of course to have a room separate from all other places in which excessive noise is present. This is because of the fact that many signals are weak and hard to read. A little noise in the same room may make it impossible for working some "DX" station. The writer's location is on the third floor of his home and is some distance from all of the other occupied rooms of the house. It is impossible to hear anyone in other parts of the house and thus complete quiet and freedom from disturbance are assured.

After having selected the room in which your set is to be located, you should make arrangements for table space. The latter is quite important, as in order to be able to do experimental work quickly and easily, the apparatus must be accessible. This it will not be if part of it is stowed under the table, another part of it on the table and the rest of it off in some closet or some other place where it cannot easily be reached. The writer has gone through all this sort of work and has used arrangements that are most unhandy. The final result of experience so gained is the extremely accessible layout shown in Figs. 1 and 3 on this and the next page. One quite large table is devoted to the receiver only. None of the transmission apparatus is on this table with the exception of the power switch and the key. These are located directly to the right of the receiver where they will be near the operator's hand when they are to be used. The rest of the table is completely clear and the operator is not cramped for space in any way whatsoever. Thus records of transmission and reception can be entered into a book placed in front of the receiving set and other work of a similar nature can be done without having to move apparatus in order to make room for the book. Over in one corner of the table is the wave-meter, a most handy adjunct to any transmitting station and one that is almost indispensable. Wave-meters have been described in various past issues of this magazine and it will pay interested readers to look them up. An instrument of this type should be at hand at all times for checking the wave-length of the transmitted wave or the wave-length of received signals.

Formerly the transmitting apparatus at the writer's station was partly on top of the table and partly under it. However, with the acquisition of an "S" tube rectifier, the old bulky and cumbersome yet efficient electrolytic rectifier could be abandoned and all of the apparatus could be quickly and easily mounted on the top of another small table placed directly alongside of the operating table. With the meter and wave-length control panel placed across the short end of the transmitting apparatus table the apparatus is easily seen by the operator at all times. See Fig. 1 for a complete view of the arrangement. The key is designated by 21 and the power switch by 23. To transmit, all that the operator has to do is to close the switch and manipulate the key. When through with transmission, flip the switch open and the power will be disconnected. This system requires the use of two aerials, a counterpoise and a ground. One aerial and the counterpoise are used for transmission, while the other aerial and ground are connected to the receiving set. Using this arrangement, no change over switch is necessary as the two sets are always connected to their own particular antennas. It is advisible, however, when working the transmitter at or near the wave to which the receiver is tuned, to push the filament switch when starting to send. This avoids the annoying key clicks in the phones and prevents paralyzing the detector tube with the strong signal that will be picked up by the receiving antenna.

APPARATUS USED

The following is a list of the apparatus used in this transmitter. The figures are the same as those on the various photographs and illustrations on the two succeeding pages.

1. 0- to 2-ampere radio frequency ammeter.
2. .0005 mf. variable condenser.
3. Antenna coil.
4. .0005 mf. variable condenser.
5. Oscillator coil.
6. .0005 mf. variable condenser.
7. 5,000- to 10,000-ohm grid leak.
8. .002 fixed condenser.
9. 0- to 15-volt A.C. voltmeter.
10. 5 or 50 watt tube socket.
11. 0 to 300 milliammeter.
12. .002 fixed condenser.
13. Two 1-mf. condensers.
14. R. F. choke (see text).
15. 30 to 50 henry iron core choke coil.
16. Four 1-mf. condensers (2000 volt test).
17. "S" tube rectifiers.
18. Double-pole double-throw switch.
19. Plate transformer.
20. Filament transformer.
21. Key.
22. Primary rheostat.
23. Fused switch.

Some of the parts used in this transmitter can be made at home with little or no trouble and in the following paragraphs the writer will outline the simplest methods for doing so.

The meters and variable condensers used in this transmitting set cannot very well be made at home and you should buy well-made instruments of a reliable type. Those used by the writer and shown in the various photographs accompanying this article are perfectly reliable. The variable condensers are of a standard receiving type and there is nothing special at all about them. Even using a 50-watt tube with 1100 volts on the plate, these condensers do not break down

(*Continued on page* 742)

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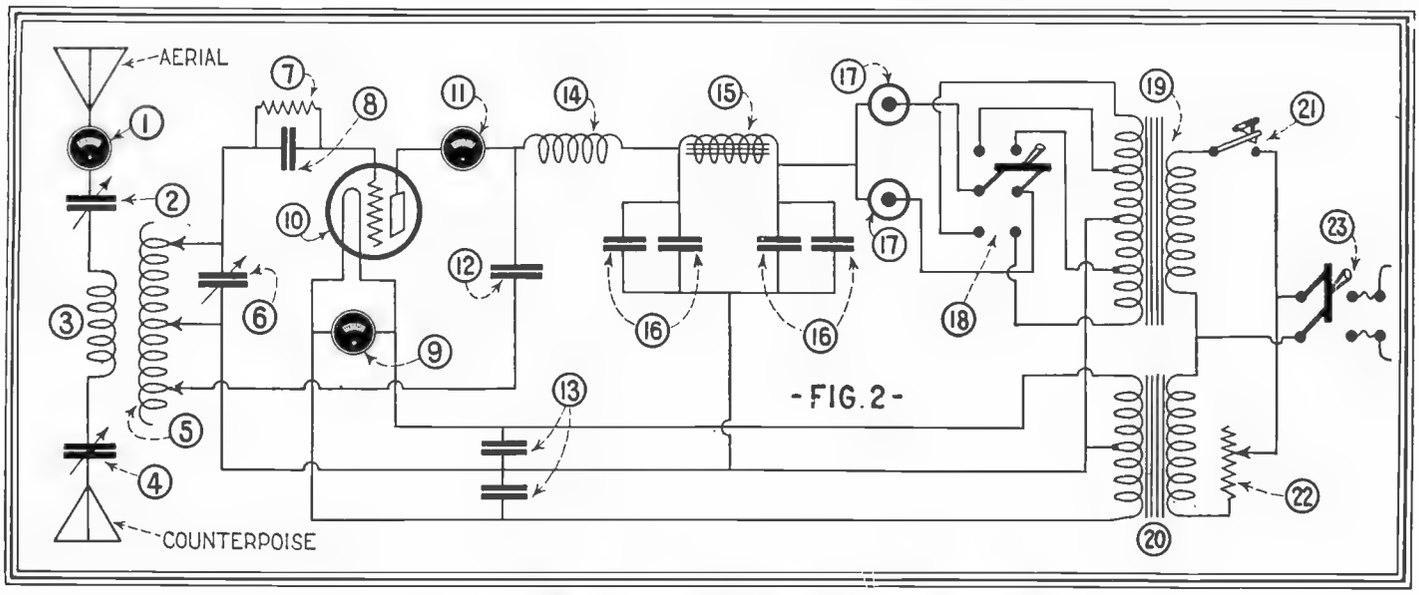
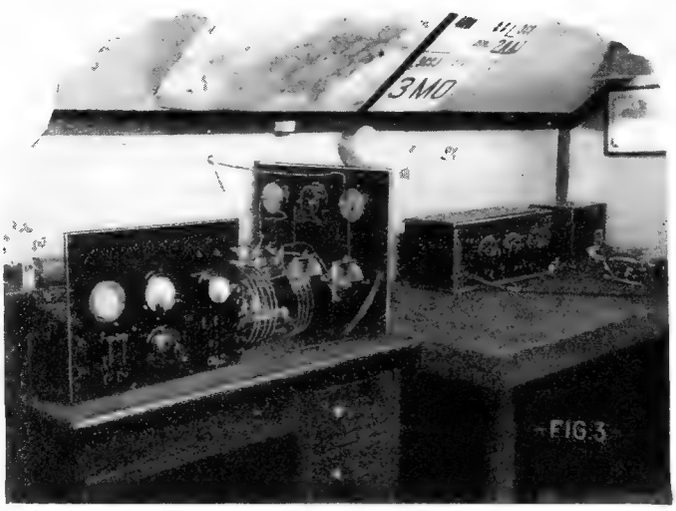


-FIG. 2-

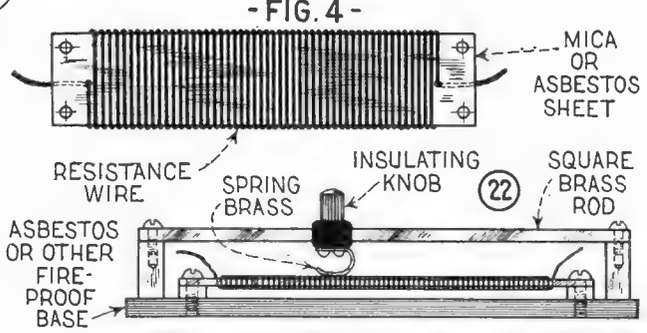
DIRECTLY above is shown the complete circuit diagram of the transmitter described in this issue. Every detail has been outlined, but a good many experimenters find it quite possible to eliminate some of the instruments that are designated in the above diagram. For instance, the variable condenser, 4, is not an absolute necessity, but is sometimes a tuning aid. By careful manipulation of the clips on the coil, 3, the variable condenser, 6, can be eliminated if the number of turns in the coil is increased somewhat. Often it is found that the condensers, 13, are not always needed, but they usually aid in clearing up the transmitted note.

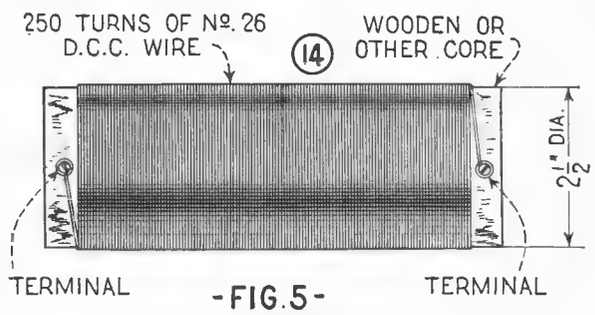


-FIG. 3-

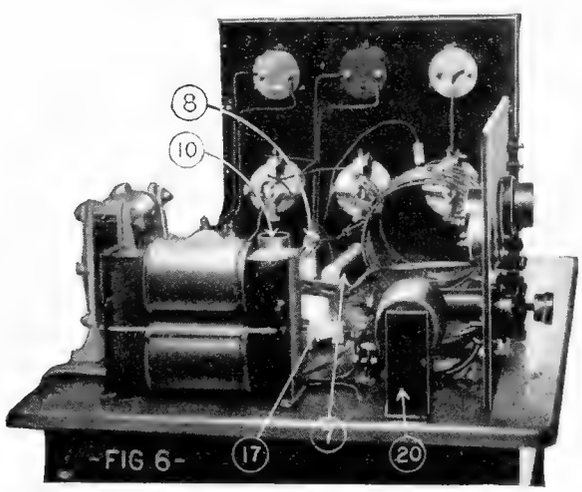
FIG. 3 at the left shows an interior view of the writer's station. The transmitter under discussion is shown at the left of the photograph. A simply constructed type of filament rheostat is shown in Fig. 4. Fig. 5 outlines the construction of the R.F. choke coil designated by 14 in the circuit diagram above. Figs. 6 and 7 show other views of the completed transmitter. The panel upon which the rheostat, 22, and the switch, 18, are mounted as shown in Fig. 7 is not an absolute necessity, but was one ready at hand when the writer was building this set. Meters for keeping a careful check on the power supply can be mounted in this location but they are not necessary.

-FIG. 4-



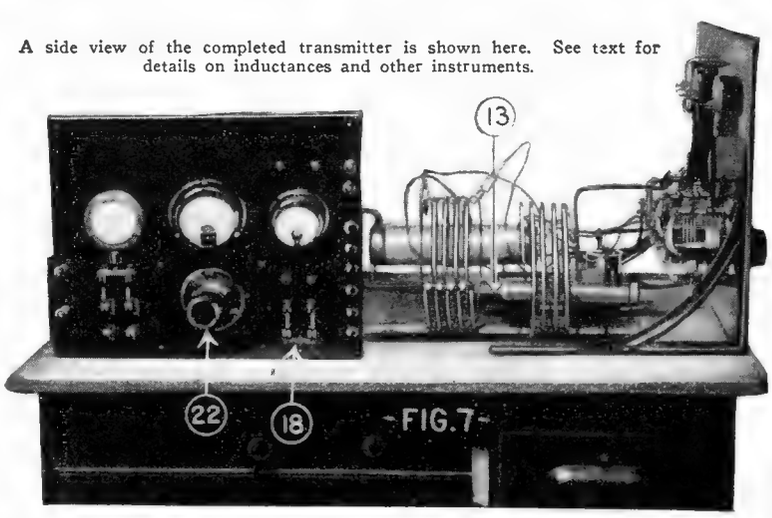


-FIG. 5-



-FIG 6-

A side view of the completed transmitter is shown here. See text for details on inductances and other instruments.



-FIG. 7-

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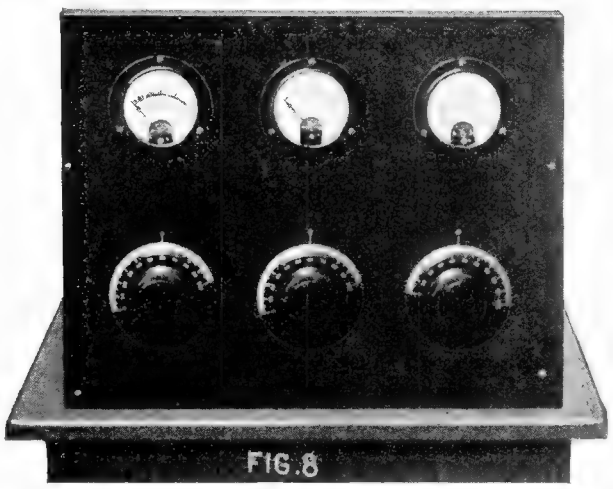


FIG. 8

The panel containing the wave-length controls and the various meters is shown directly above. The dial indicators are scratched in the panel and then filled in with white paint.

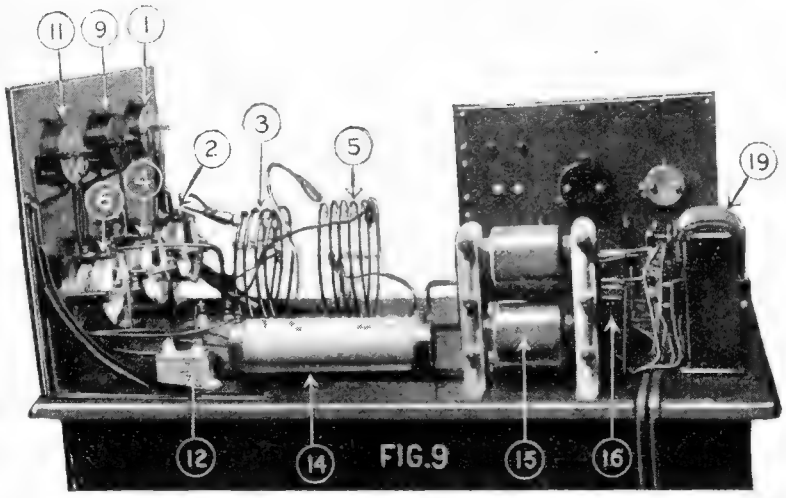
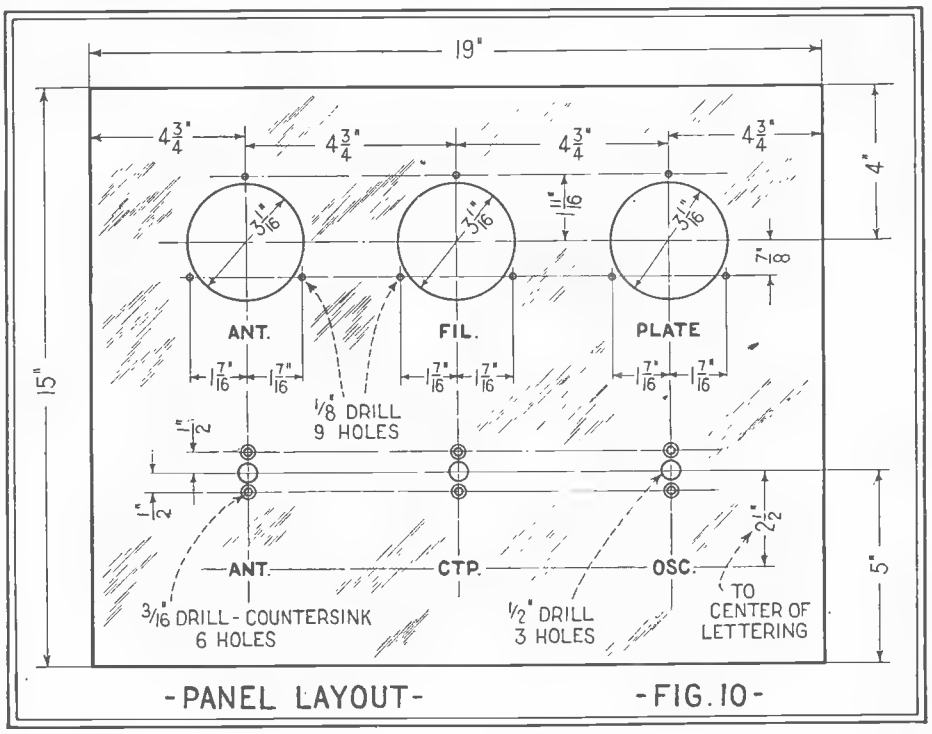


FIG. 9

Another side view of the transmitter is shown here. The filter choke coil and the plate transformer can be seen at the right-hand end of the photograph. The R.F. choke coil is in the center indicated by 14.

THE panel layout of the wave-length control and meter panel is shown directly at the right. The size of the meter holes are correct to fit the particular type of meters that the writer used. Quite a commercial-like appearance can be added to the set if the lettering indicated in Fig. 10 is placed directly on the panel. This can be done with white ink or the letters can be engraved and filled in with white paint. Be sure that the condenser designations are placed far enough below the center line of the condenser shafts, so that the dial will not cover part of the lettering. The condensers used in this particular set were of the type that required three holes for mounting and these are indicated in detail.



-PANEL LAYOUT- -FIG. 10-

IT must be realized that the various layouts of apparatus and panels given on these pages need not be absolutely adhered to. However, the arrangement has been made with convenience in mind and unless you have some definite reason for changing the arrangements, you will do better to follow the various details given herewith. Every piece of apparatus is absolutely accessible to the operator at all times, and any changes that may become necessary can be made without the necessity of removing several other instruments to get at the one to be changed.

Directly below are the details for making an electrolytic rectifier, the inductance coils and the cores for either transformers or filter choke coils.

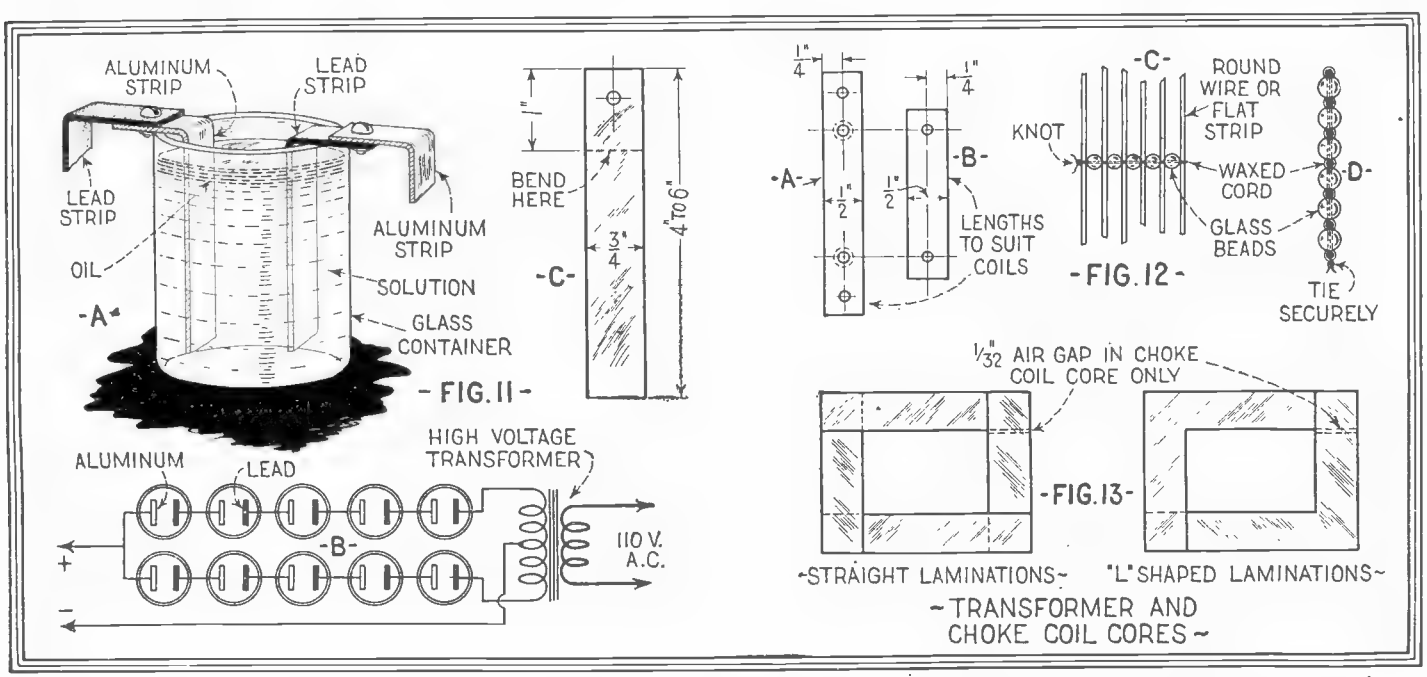


Fig. 11 gives all of the necessary details for constructing an electrolytic rectifier and for connecting it in a circuit. Follow carefully the directions given in the text when making this unit. Fig. 12 shows coil construction and Fig. 13 how transformer and choke coil cores are made.

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The Radio Constructor

(*Continued from page 739*)

or flash over except occasionally when the set is improperly tuned. No harm is done by this flash over in this circuit. Under actual operating conditions they can be depended upon to "deliver the goods" at all times. Many experimenters when working on short waves have found that two of the three variable condensers can be eliminated. Only one is used in series with the antenna and the primary or oscillator tuning is accomplished solely by varying the positions of the three clips. Tuning is a much harder process in this way but the cost of the completed installation is reduced. In practically all cases, the counterpoise series condenser can be eliminated and the secondary inductance connected directly to the counterpoise.

The instruments that the writer has used are adaptable to either a 50-watt or a 5-watt set. In other words, tubes of either rating can be used with the same instruments and with few if any changes. The only difference is that the 1100 volt side of the plate transformer should never be used on a 5-watt tube. Doing this will cause the tube to break down and become useless. Do not try it even though you think that you can get greater distance in this way. The filament transformer will operate either one of the two tubes mentioned. In fact, it will operate three or four 5-watt tubes in parallel. It will not, however, operate one of the old style 50-watt tubes that draw 6.5 amperes, but it will prove amply large enough for a newer type of tube drawing on the order of two or three amperes.

THE INDUCTANCES

It is rather difficult to purchase short-wave transmitting inductances on the open market at the present time, but it can be done. However, they are rather expensive and the average amateur constructor will undoubtedly want to build his own. The writer did that and evolved a very satisfactory type of coil that can be quickly and easily made. Either edgewise wound copper ribbon ½ inch wide by 1/16th inch thick, wound in a circle five inches in diameter or No. 6 or No. 8 bare copper wire, wound in the same sized circle can be employed. The type of ribbon mentioned must be purchased. It cannot satisfactorily be wound at home. In either case, the method of spacing the turns is exactly the same and is simple in the extreme. Glass beads and strong waxed linen thread perform this duty. All of the details for this work can be seen in Figs. 12C and 12D. The strip or the copper wire is wound in the required form and then the beads are placed between the turns and held in position by means of the waxed thread. The thread is pulled as tight as possible and knotted securely over the last turn of the inductance.

In general, for 40 meter work, 6 turns of wire in a form 5 inches in diameter will be all that are required for the oscillator coil. The antenna coil should have from 3 to 5 turns and its exact size should be determined by experiment. Clips and flexible leads are used to make connection to the various turns of the inductances. The writer used flexible lamp cord for the leads and strong spring clips for making the actual contacts. The inductance coils are mounted in an upright position on the table as can be seen in the various photographs. Two bakelite, hard rubber, celeron or radion strips are used for mounting each inductance and they are detailed in Figs. 12A and 12B. The long strip goes between the coil and the table and the short strip goes inside the coil and clamps to the longer one. These coils should not be permanently fastened to the table until the best relative distance between them is determined under actual transmitting conditions. In the drawings of these strips no dimensions are given in regards to the length as they will vary according to the way in which the builder constructs the coils. Make them amply long enough so that the turns in the inductance will not touch the mounting screws.

A good many amateurs attempt to construct their own grid leaks and grid condensers. This, however, is not advisable. A few dollars spent here will relieve you of a lot of trouble and time consuming work. Even at that, home-made high voltage condensers and good home-made grid leaks are a rarity and are hardly worth constructing. However, even though a fixed grid leak is shown in the accompanying photographs, still a variable type can be used. A good many experimenters have achieved excellent results when using variable resistances as grid leaks such as the type designed to be used across the secondaries of audio frequency amplifying transformers. Such a variable resistance should have a range of from 5000 to 25,000 ohms. Even higher than this can be employed. The exact value and the correct setting of the variable grid leak will depend almost entirely upon the tube used and upon the way in which the set is tuned.

Want a New Thrill?

Try radio transmission! You will get a bigger punch out of actually talking to some other ham a thousand miles away than receiving from a broadcasting station 3000 miles away. On the short waves, no quiet hours need be observed and you can operate for 24 hours at a stretch if you so desire and can keep awake. This article gives all the details on a complete transmitter that will help you towards that thrill.

POWER SUPPLY

Since the majority of amateurs will have A.C. available for their power supply, we will consider that almost entirely in this article. Where D.C. is the only source available, motor-generators must be resorted to for both filament and plate supplies. However, such machines cannot be constructed and must be purchased so we will not consider them here.

It is preferable to heat the filament of a transmitting vacuum tube with A.C. and in fact all transmitting tubes are of such a rating that they could not be operated from a six volt storage battery. Therefore, we will first consider the construction of a filament transformer. True, it is possible to make one transformer that will supply both filament and plate currents, but this is not desirable for many reasons. Its only advantages are in its compactness and lower cost. In the end it is far more satisfactory to make separate supply units. In Fig. 13 we show two different methods of building up transformer cores. No air gaps are used in them. The material used is preferably silicon steel strips .014 inch thick. For the filament transformer, use strips 1.5 inches wide and build the core up 5 inches square in outside dimensions with the legs 1.5 inches high. The primary consists of 550 turns of No. 22 D.C.C. wire and the secondary of 70 turns of No. 12 D.C.C. wire, tapped exactly at the 35th turn. On a voltmeter test, the voltage between the center tap and either end must be exactly the same. If not, shift the center tap until they are.

With a transformer of this nature, some type of primary rheostat must be used. Do not use a rheostat in the secondary circuit as this will destroy the use of the center tap and unbalance the circuit. An excellent type of manufactured rheostat operating on the carbon pile principle is used by the writer and may be seen in Fig. 7, being indicated by No. 22. This rheostat gives very fine control over the voltage in the secondary circuit. If, however, you desire to make your own, a suggestion for this work is given in Fig. 4. The resistance wire can be obtained from an old electric pressing iron heating unit and should be rewound upon a non-inflammable insulating strip. The dimensions are not given in the drawing or here because of the fact that you will probably want to change them to suit materials at hand.

THE PLATE TRANSFORMER

A very satisfactory transformer for supplying the plate current to one or more five watt tubes can be built up on a core having legs 2 inches square, the entire core being 8 inches square in outside dimensions. This core is also built up of strips of silicon steel .014 inches thick. The primary is wound with 440 turns of No. 15 D.C.C. wire and the secondary with 8000 turns of No. 24 D.C.C. wire. The latter should be wound in layers and every second layer should be covered with a strip of thin paraffin paper. Taps are brought out at the 2000th, 4000th and 6000th turn. The 4000th tap is the center tap and the other two supply 500 volts. In case you are only going to use a 5 watt tube, use only 4000 turns on this transformer tapped at the center. With a 50 watt tube it is advisable to have the two voltage ranges available so that low power can be used for short distance work or so that new tube rectifiers of the type mentioned below can be "broken in" on a low voltage before submitting them to 1000 volts. In winding a transformer of this type where many turns are required, wind half of the primary on one leg and the other half on the other. Then wind half of the secondary over one of the primary sections and the other part over the rest of the primary. Be sure that all coils are wound in the same direction. The winding is preferably done on a form or spool that can be slipped over the core legs.

RECTIFIERS

Probably the most satisfactory form of rectifier available for the average amateur is the "S" tube type and connections for the tubes are indicated in the diagram in Fig. 2. These tubes can be purchased on the market today at a rather reasonable figure, considering their long life. Once having been installed in the circuit and preferably broken in on low voltage, say around 500 volts, they can be used almost indefinitely unless an abnormal voltage is applied whereupon break-down may take place. This, however, is no fault of the tube and the user must avoid overloading them if he would obtain the best results for his money. The writer is personally using "S" tubes at the present time and is obtaining exceptional results with them. They give almost perfect rectification with a comparatively low voltage drop through the rectifier.

Some experimenters, however, prefer to make their own rectifiers and in this event the electrolytic type is the most satisfactory. It consists of several electrolytic rectifier cells connected as shown in Fig. 11B. The details of the rectifier jars are given in Figs. 11A and 11C. The elements are made up of lead and aluminum strips, cut to the size

(*Continued on page 773*)

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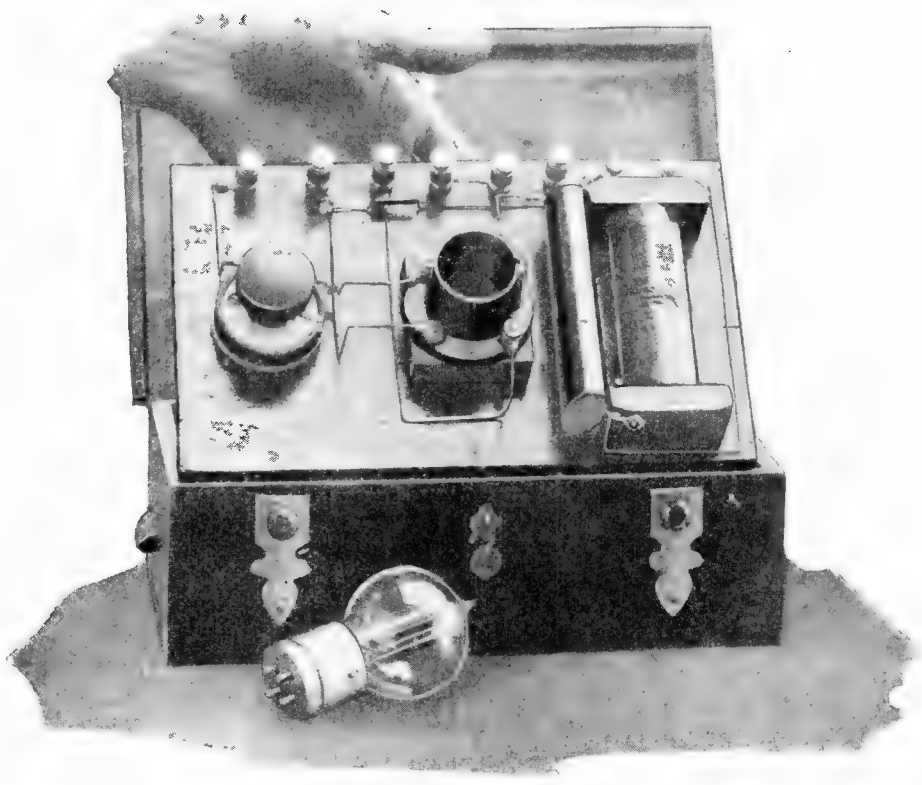
Novel Audio Frequency Amplifier

By R. L. YOUNG



The interior layout of this novel third stage audio-frequency amplifier is shown above. Notice the extreme simplicity of the wiring and the arrangement of the binding posts. The latter system allows all of the leads to the amplifier to be brought out through the back of the cabinet, thus eliminating unsightly wires in front of the unit. In this particular amplifier, the Ford spark coil has been provided with wooden ends which are used to support it. The rheostat does not need frequent adjustment and therefore can be located inside of the cabinet.

AN audio frequency amplifier, that can be used to give a third stage of amplification with a minimum of distortion and noise, may be constructed from a few simple parts as described below and illustrated here. The writer chose a novel cabinet for housing this unit. It consists of a miniature cedar chest that was formerly used as a novelty packing box for candy. Of course, the parts illustrated can be adapted to mounting in any type of cabinet that the reader may desire, with no difference in results.

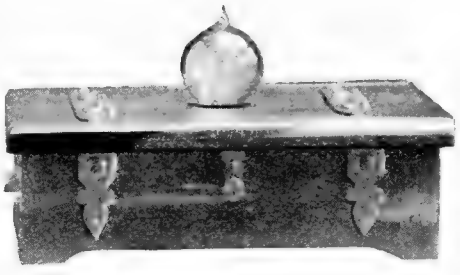
The essential parts of this instrument, aside from the usual binding posts and tube, are a socket, a Ford coil and a rheostat. After you obtain the Ford coil, and it is a wise idea to use a new one rather than a second-hand one, because often the latter are burned out before they are discarded, remove the casing and melt out the wax so that the condenser and the coils can be easily worked on. Preserve both of these carefully as they are to be used in the set. Remove all the connections, being sure to leave sufficient wire on the ends of the secondary coil to allow for future connections and also preserve the connections to the condenser. The next step is to distribute the instruments on a suitable baseboard and the arrangement shown in the photographs is to be recommended. Wire them up according to the diagram given, using only the two secondary coil connections. The primary is disregarded but left in place together with the core.

In connecting this unit to your present receiving set, connect the two input binding posts to the output binding posts of the amplifier of this set. Connect the "A" battery leads of the amplifier to the regular "A" battery, so that the same source of current heats the filament of all the tubes. The "B" battery should be a separate unit but it may be the common one that is used on the other tubes, if great economy must be practiced. If, however, the best results and the clearest reproduction are desired, use the separate "B" battery.

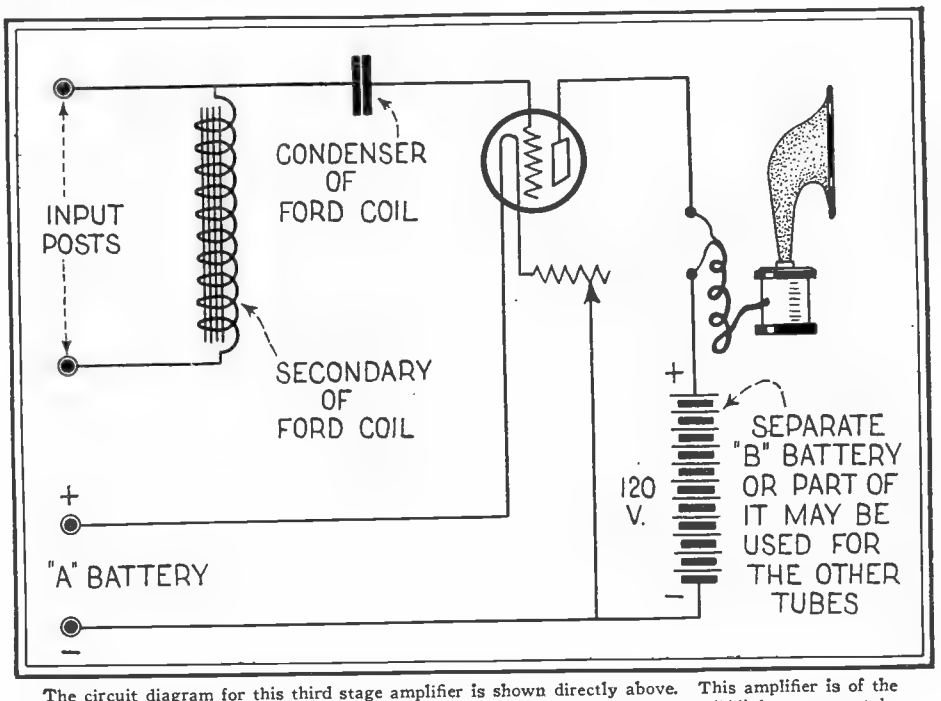
The writer uses this amplifier with either a VT-2 or 216A power tube. With 120 volts of separate "B" battery applied to the plate, wonderful results are obtained. It is possible, however, to use a UV-201A, with the normal "B" battery voltage applied to it. In this case volume will be sacrificed.

After you have connected the amplifier to your set, it is possible that it may not work on first trial. In such case, reverse the wires to the input binding posts and if the directions given above have been followed and the connections are made correctly, the amplifier will work perfectly.

(Editor's note. The amplifier that Mr. Young has built and which is described on this page is most certainly a step in the right direction for the amateur radio builder to take. The making of various radio reception units from odds and ends of electrical apparatus is a hobby that not only gives enjoyment, but at the same time is a financial relief from the purchasing of high-priced apparatus. We like Mr. Young's idea and hope that a good many of our readers will follow in his path.)



The completed assembly with the cover closed and the tube in position. The cabinet used makes a most effective ornament for any radio receiving set.



The circuit diagram for this third stage amplifier is shown directly above. This amplifier is of the impedance coupled type and in order for it to operate correctly, the same "A" battery must be used on the filament of the amplifier tube, as is used on the other tubes. The grid condenser is very necessary to prevent the high voltage from reaching the grid.

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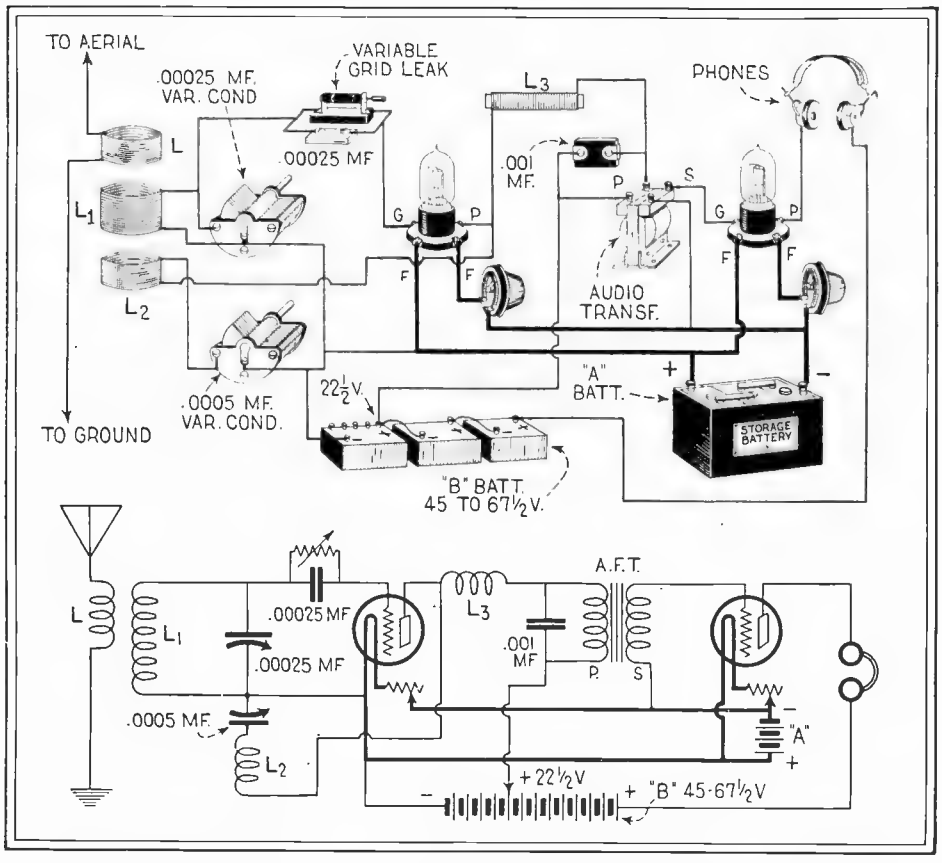
RADIO ORACLE

In this Department we publish questions and answers which we feel are of interest to the novice and amateur. Letters addressed to this Department cannot be answered free. A charge of 50c. is made for all questions where a personal answer is desired.

SHORT-WAVE RECEIVER

(416) Q. 1. Maxwell Kline, Stamford, Conn., requests a circuit diagram of a short-wave receiver that can use interchangeable coils for tuning over various bands of wave-lengths.

A. 1. In these columns you will find the requested circuit diagram. The coil, L, consisting of three or four turns of wire on a 3½-inch form



A short-wave receiver opens new fields for the radio enthusiast. An excellent type for use with headphones is shown above. The data for coils covering the 40 and 80 meter amateur band is given in the text. Follow it carefully in order to obtain the best of results.

may be used for practically all waves that this set will cover. The coils L_1 and L_2, however, must be changed for the various bands. In general, L_2 will have half as many turns as L_1. For the 40-meter amateur band use eight turns in L_1 and five in L_2. For 80 meters use 16 turns in L_1 and 10 in L_2. The choke coil L_3 is permanently wired in the circuit and need not be changed. One hundred turns of No. 26 S.C.C. wire on a 1-inch form will be sufficient.

TYPE OF RECEIVER

(417) Q. 1. James H. Fougner, Gilsum, N. H., asks what kind of a receiving set we would advise him to buy.

A. 1. The particular type of receiving set that you will need depends upon whether or not you desire to operate a loud speaker or are content to listen in on headphones. In the latter event, any standard one- or two-tube receiving set would be quite sufficient for your needs. If, however, you wish to use a loud speaker, at least three or possibly four or five tubes should be employed The circuit you mention in your letter is quite good, but if you wish consistent loud speaker reproduction, we would advise something similar to a Neutrodyne.

Patterns delineating the design and construction of various types of receiving sets can be purchased for a nominal sum. We will be glad to furnish anyone with the name and address of a company supplying them upon receipt of a stamped, addressed envelope.

SQUEALING

(418) Q. 1. S. J. Fort, Menno, S. D., has built a radio receiving set following directions given in this magazine some time ago. The set works perfectly on the detector alone, but when the two stages of audio frequency amplification are used, squealing is present that makes reception almost impossible. He asks our aid in locating this trouble.

A. 1. There are several points in connection with your receiving set that must be looked into. Possibly the leads in your transformers are reversed. Try reversing them one by one. If the trouble does not disappear, make sure that your "B" battery is of the correct voltage. Too high a voltage on the detector would cause the results you mention. If you are not using a "C" battery, it might be well to try one of about 4½ volts in the grid circuits of the amplifier.

Furthermore, we would advise that a 10 to 1 transformer very often gives poor results. We would most heartily suggest that you replace this one with a transformer having a 5 to 1 ratio.

Furthermore, you should keep your grid and plate leads separate and not run them parallel for any great distance.

Also, be sure that the cores of the transformers are at right angles to each other. If parallel, trouble may arise unless they are shielded.

We believe that if you will look into all the above-mentioned points you should be able to locate your trouble.

TWO-TUBE SET

(419) Q. 1. Frank A. Fick, Santa Cruz, Calif., refers to a set described in the April, 1925, issue of this magazine and asks how the double wound coil described therein is to be made.

A. 1. In regard to winding the double wound coil in the radio receiving set you mention, we would advise you to measure off the length of wire necessary for winding one of the coils, double this length and connect the center lead to the point where the wire is doubled. Then proceed with the winding of the form exactly as though one wire only was being used, except, of course, laying the two wires together in the spider-web form.

Q. 2. Will a neutralizing condenser, consisting of two flat-head brass screws placed end to end and separated about one-sixteenth of an inch have sufficient capacity for this circuit?

A. 2. We would advise you to use a larger capacity of neutralizing condenser. Probably soldering two 1-inch discs of copper to the machine screws you show in your letter of recent date would give a large enough capacity. The space must be varied until the best results are found.

"B" ELIMINATOR PARTS

(420) Q. 1. William T. Edwards, New Rochelle, N. Y., asks where he can purchase parts for the various "B" eliminators described in September, 1925, issue of this magazine.

A. 1. We will be only too glad to forward you the names and addresses of companies supplying the various parts upon receipt of a stamped addressed envelope.

DETECTOR HOWLS

(421) Q. 1. Ben Crawford, Powers, Ore., has built a four-tube set using one stage of R.F., a regenerative detector and two stages of A.F. He says that the only way the set will operate at all is with the detector tube filament just barely turned on. Heating the filament further causes the set to howl. Also there is often a scraping sound noticed when the variable condensers are being adjusted. He asks our aid in locating his trouble.

A. 1. First consideration of your problem seems to point toward the wrong value grid leak or grid condenser. Also it is quite possible that your detector tube is not getting the correct plate voltage. Try varying this voltage.

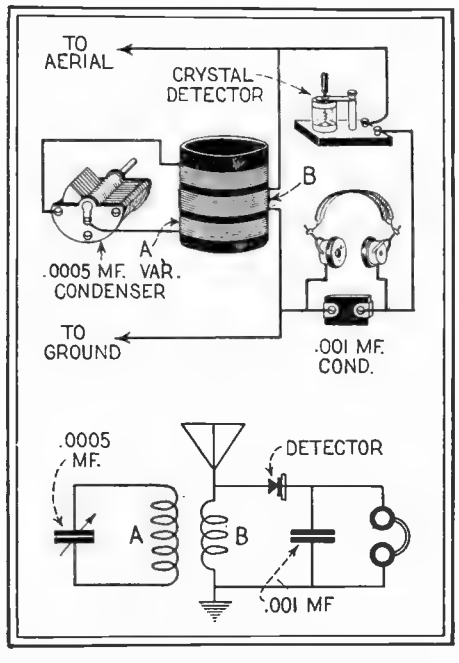
Possibly your variable condenser plates are touching and such can be easily determined by observation. If they are, pry them apart a short distance until they do not scrape. It would seem, however, that aside from the little noise that you get in your set you are getting very good results. Undoubtedly fixing the variable condensers and substituting grid leaks and condensers until you find the right values will clear up your trouble.

CRYSTAL RECEIVER

(422) Q. 1. W. L. Calvert, San Pedro, Calif., asks how to connect up a crystal detector with an absorption type of tuner.

A. 1. The connections are very simple as can be seen in the accompanying diagram. This tuner is quite sharp and the details are as follows: Coil A is 50 turns of No. 22 D.C.C. wire on a 3½-inch form. Coil B is wound on top of coil A and insulated from the latter by a layer of paraffined paper. Coil B consists of 12 turns of No. 22 D.C.C. wire.

A very good kink can be readily perceived from the accompanying sketch. A wave-trap can be converted into a crystal detector circuit by connecting the detector and phones across the antenna and ground terminals of the wave-trap in the same manner as they are connected across coil B in the accompanying diagram. The aerial and ground are also connected to the same posts and the output terminals of the wave-trap are not touched. This, of course, applies to the usual inductively coupled type of trap, wherein two coils similar to A and B in our diagram are employed.



A simple crystal detector circuit using the absorption method of tuning is shown above.

AmateurRadioHistory.com

Non-Sc(i)ence

MANUFACTURE OF WOOD PULP

The following item appeared in the "Chaperon" columns of the *Kansas City Star* on July 15th, 1925: "A woman is seated immediately when she enters a restaurant. If she wishes, she may then slip out of her coat, spreading it back on the **back of her chair as she eats.**"

This, no doubt, refers to the days of "Tarrano the Conqueror," when many things will be used for food that are not used now. A vegetarian, we presume, should include wood as part of his repast. Soft wood may be easily digested, but hard wood is better for the molars.—*Miss Minnie Stevens.*

SHELL AND ALL

In *Sidney Smith's famous news comic of the "Gumps,"* we find a picture in the Sunday paper of the scene illustrated herewith, depicting little Chester and the Chinaman with necks outstretched awaiting the descent of the fatal blade. At the critical moment a well-directed shell from Uncle Bim's ship shatters the idol and all are saved. The projectile, however, probably by accident, has carried the cartridge, or shell case, along with it, and one wonders what happened to the gun as the cartridge tore its way through the rifling, or how the aim could be so straight and, incidentally, one wonders where the propulsive charge was located which started the ensemble going. Will some ex-gob of 1918 please elucidate?—*L. O. Lofquist.*

OFF AGAIN—ON AGAIN

In the edition of the *Camp Lewis News*, dated September 12th, 1925, we find the following: "Sgt. Goldstein is trying to invent a way to get **on a horse from the off side.**"

Using this method of procedure, how would the man approach the animal in order to get away from him?"—*Geo. Dewey Smith.*

A NEW INSTRUMENT

The following advertisement appeared in the *Ace High Magazine* for August: **"Have ukulele, half coonhound and half airedale (male),** flashlights. Want guitar .22 repeater."

Now, what kind of a genius invented this contraption? Evidently all the freaks are not in the circus. We wonder whether musicians play on the coonhound and airedale combination, and whether one can find accomplished musicians to play on the pesky critter. We should want our ukulele pedigreed.—(*Author please send name.*)

Money for Science Mistakes

The newspapers throughout the country, as well as the magazines, occasionally err. Sometimes these errors are misprints. At other times they are pure scientific misstatements. If you happen to see any of these humorous mistakes in the press, we will be glad to have you clip them out and send them to us. Give the name of the newspaper or magazine in which the error appeared and accompany the inclosure with a few humorous lines. The most humorous ones will be printed in this department, and for each one accepted and printed we will pay $1.00. No NON-SC(i)ENCE entry will be accepted, unless the printed original accompanies the same. All NON-SC(i)ENCE entries must be scientific and addressed to:

Editor, NON-SC(i)ENCE Dept., c/o Science & Invention Magazine, 53 Park Place, New York City.

RIGHT THROUGH

In the August *Popular Science Monthly* I find the following statement: "An ingenious **camera that photographs the interior of the stomach** was displayed recently at Atlantic City, N. J. The apparatus consists of a metal tube that can be slipped down the patient's **windpipe.** At one end of the tube is a powerful electric light that illumines the stomach, and at the other end a special camera, with a series of lenses in between."

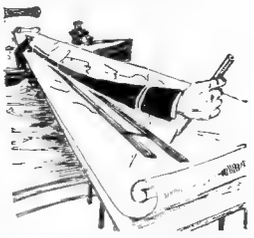
"Well, this is certainly an ingenious camera. Indeed, by the time the tube has reached the stomach by way of the "windpipe," the patient will be dead enough to enable the physician to carry on a postmortem examination. Such an examination should be more "enlightening."—*Mrs. Chas. L. Williams.*

SOME DEPTH

The *Daily Press* of Newport News, Va., for Sunday, September 13th, 1925, contained the following item: **"The Antarctic Ocean has an average depth of 5,731 miles."**

As the mean diameter of the earth is 7,700 miles, and the polar diameter is 7,899.984 miles, either one of two things must be conceded. If this depth of "5,731 miles" be correct, the whole Antarctic end of the earth is an abysmal sea of water, or there is an enormous hole in the bottom of the earth deeper than half the distance through the earth straight to the North Pole. A miss is as good as a mile, but here the typographical error amounts to about 5,731 miles. Quite a "miss!"—*J. L. Kibler.*

A LONG STRETCH



In the April, 1925, issue of *Popular Mechanics* appears an article on sleuth hounds of the sea in which we find the following statement: ". . . and officers mark on a chart a series of parallel lines A QUARTER OF A MILE APART . . ."

Evidently these officers have extraordinarily long arms in order to reach the two extremes of the chart a quarter of a mile apart. We hope that the chart is well supported between ships, as it would be difficult to place a chart this large in one vessel. I have not as yet heard of any United States ship one-quarter of a mile long which will accommodate this record.—*Sidney Lang.*

A HEAVY SHADOW

In an advertisement appearing in the September, 1925, edition of the *Classic*, we find the Silph Reducing Chewing Gum advertised for removing fat. The photograph shows a picture of a beautiful Brooklyn girl and under it we find this caption: "I AM THE SHADOW OF MY FORMER SELF." The remarkable part of it is that the shadow is almost twice as large as the photo of the girl. I am sure that most girls would rather be the original figure than the shadow, and that the advertisers got their statements twisted and should have said, "I am not the shadow of my former self."—*Harold E. Skelton.*

NE'ER THE TWAIN SHALL MEET

The following item appeared in the August 15th, 1925, edition of the *Portland Oregonian*: "Lost — White male collie with sable **markings on west side.**"

I would like to know which side of a collie is its west side, especially if the dog is facing west. Under these circumstances, the dog would not have a west side—it would be a west end, would it not?—*Harold Charters.*

I WILL NOW SING A SEXTETTE

In the *Grand Rapids Herald*, Sunday morning, August 30th, 1925, a photograph of three horses was shown. Under it we find the following caption: "An interesting feature of the annual convention of the New York State Volunteer Firemen's association was the **three-horse team of five horses** which still faithfully pull one of the engines of the Mamaroneck, N. Y., fire department."

Now that we have a three-horse team of five horses, we hope someone will give us a five-sided triangle.—*L. G. Winegar.*

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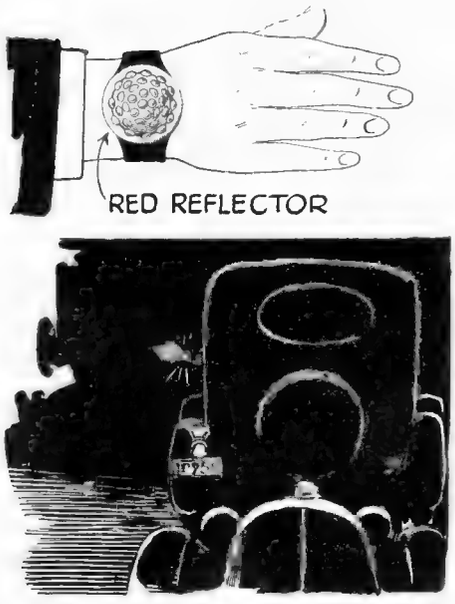
LATEST PATENTS

Auto Signal

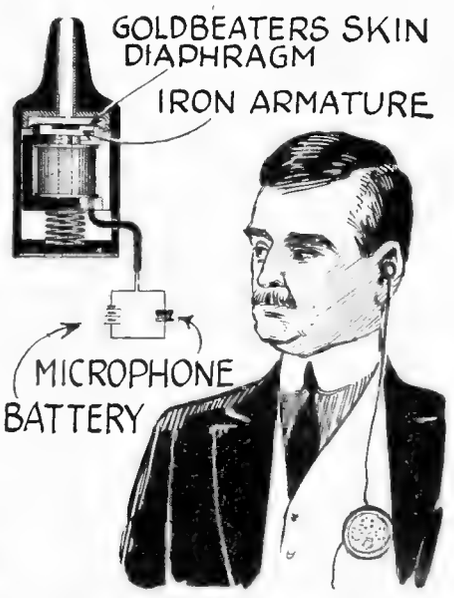


No. 1,548,916 issued to J. R. Thompson describes a night signal device for automobiles that requires no mechanical or electrical connections and that always operates if the lights of following cars are turned on. It merely consists of a red reflector strapped to the wrist of the driver. All of the standard hand signals can be given with this device in use.

Broom Holder

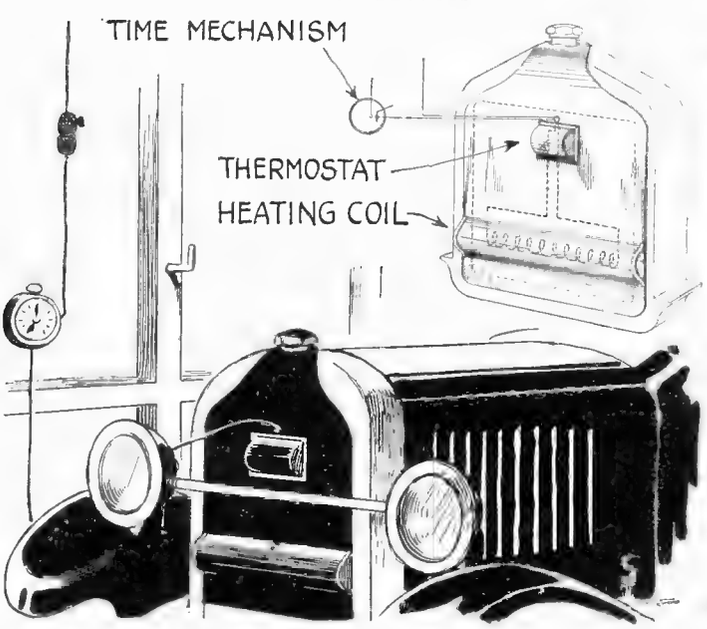
No. 1,540,291 issued to W. P. Sessions pertains to a novelty that should find wide use among housewives. The broom holder is screwed to the wall and to hold a broom in position it is only necessary to push it upward through the hole and release it. The catch holds the broom in place. To remove, lift up the bottom of the catch with the finger and take the broom out.

Small Telephone



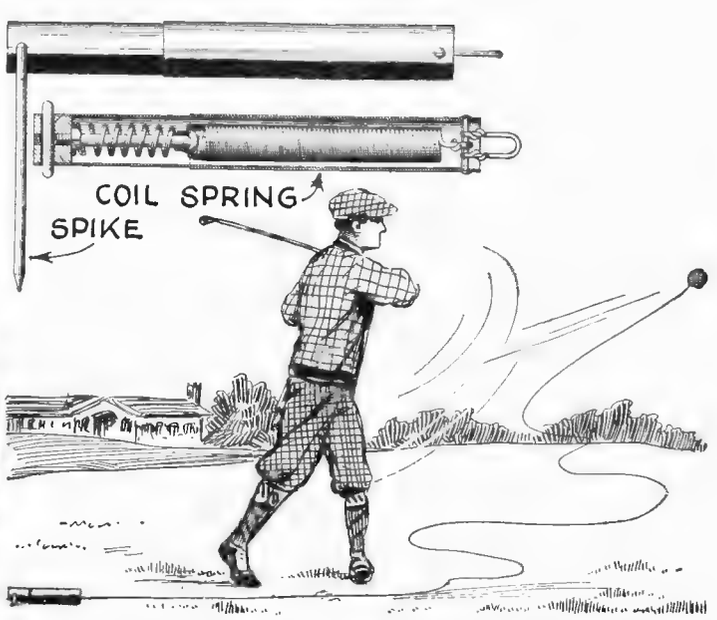
No. 1,545,525 issued to H. Sell protects a novel type of very small telephone receiver that fits into the ear and requires no head band or other holding device. The details of one of the receivers are shown in the upper left-hand corner and the device is illustrated in use above. It can be used for various purposes, the most important being as an aid to people hard of hearing.

Radiator Heater



No. 1,534,220 issued to A. J. Kercher covers a device that should make cold weather motoring more of a pleasure and that certainly will prevent an excessive drain on the battery when starting. Actuated by a clock, the heating coil is turned on at a predetermined time, but if the car is not used in a short period, the device cannot overheat because of the thermostat included. The apparatus is removed when the car is taken out of the garage.

Golf Practice Device



No. 1,541,420 issued to G. H. Lambert protects a device that enables golf practice to be carried on in a limited space. Furthermore, it enables the golfer to practice driving without having to chase the ball. As shown, a heavy coil spring is connected to a long cord, to the other end of which the ball is fastened. The ball is placed on a tee in the usual way and driven. It can only go as far as the cord will allow it to travel.

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Scientific Humor

GOTTA HAVE SOME FOR VACUUM TUBES

PROFESSOR: "A vacuum is lighter than any gas known."

BRIGHT FRESHIE: "Why don't they fill dirigibles with it, then?"—*Charles A. Voelckel.*

BEEF WAS HIGHEST WHEN COW JUMPED OVER THE MOON

"How much is this meat?"

"Thirty-eight cents a pound, ma'am."

"That's very high, but I guess that's the aviation meet I've been reading so much about lately."—*A. Andersen.*

IS THIS A SKIN GAME?

TEACHER: "Can anyone tell me who Luther Burbank is?"

DUNCE: "Aw, he's nothin' but a grafter."—*Leland Ray.*

ANYTHING THAT GOES UP

GEOLOGY PROF.: "How many kinds of water-falls are there?"

SOPHOMORE: "There are three kinds: one is the geyser. This is the kind where the water falls up."—*Leota E. Schoff.*

CAN YOU PICTURE THIS?

SHE: "Why is a flapper like a spoiled film?"

HE: "Because she's under-developed and over exposed."—*M. Bercovitch,* Reporter No. 21358.

RELATIVELY SPEAKING

PROF.: "What is the difference between the Einstein theory and the Darwin theory?"

STUDENT: "Einstein says that all things are relative and Darwin says that all things are relatives."—*Harold Phifer.*

THIS ONE DIDN'T

DAD: "Son, what do you mean by trying to fold my rule sideways, when it should be pushed together. You've broken it."

SON: "Aw, Dad, I didn't mean to, but you said a good rule should work both ways."—*Murray Orser.*

STRETCHING THE TRUTH

ADAM: "Do you believe that story about Lot's wife turning into a pillar of salt?"

EVE: "Why not? Whenever you see a flapper pass you turn to rubber."—*Jas J. O'Connell.*

NOT A LIE DETECTOR

DE STYLE: "If George Washington was living today he could never get a job in a chemical works."

GUNBUSTA: "Why not?"

DE STYLE: "He could never tell a lye."—*F. P. Pitzer.*

SOMETHING FOR NOTHING

Toricelli, the man who first made a vacuum, was the only inventor who produced absolutely nothing, and got credit for it.—*M. Bercovitch,* Reporter No. 21358.

FIRST PRIZE $3.00

HE'LL GET IT

PROVOKED WIFE (discovering drunken husband on front steps fiddling with door knob at 2:00 a. m.): "What are you doing there, John?"

DRUNKEN HUSBAND (still turning knob): "Pshh! I'm trying to get Los Angeles."—*L. Keiser, Jr.,* Reporter No. 27612.

THIS MAKES THEM COLD-BLOODED

QUESTIONER: "And how is the climate there?"

MISSIONARY: "Oh! The only trouble is that they have to feed cracked ice to the hens so they won't lay hard-boiled eggs."—*Wolfe N. Bishop,* Reporter No. 22554.

WE receive daily from one to two hundred contributions to this department. Of these only one or two are available. We desire to publish only scientific humor and all contributions should be original if possible. Do not copy jokes from old books or other publications as they have little or no chance here. By scientific humor we mean only such jokes as contain something of a scientific nature. Note our prize winners. Write each joke on a separate sheet and sign your name and address to it. Write only on one side of sheet. We cannot return unaccepted jokes. Please do not enclose return postage.

All jokes published here are paid for at the rate of one dollar each, besides the first prize of three dollars for the best jokes submitted each month. In the event that two people send in the same joke so as to tie for the prize, then the sum of three dollars in cash will be paid to each one.

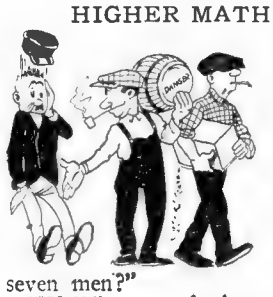
SOME BABY

SLIM: "Did you hear about that baby that gained 100 pounds in a month because it lived on elephant's milk?"

JIM: "Naw, it can't be done. Quit your kidding."

SLIM: "Sure it was the elephant's baby."—*Dan C. McCall.*

HIGHER MATHEMATICS



"Hey, you two handle that gunpowder carefully!"

"Why?" they asked.

"Don't you know that some of that same stuff exploded last month and killed seven men?"

"Well," one of the two replied, "that couldn't happen now, there are only two of us here."—*Edward D. Muir,* Reporter No. 14122.

WRNY's MASCOT

MARY: "Oh, yes, my dear he has wireless eyes."

GEN: "Wireless eyes?"

MARY: "Yes, my dear. You see he has a broad cast in them."—*Frank Anderson,* Reporter No. 16895.

U R 2 Ys

"What is Na_2O_7?"

"Never heard of it."

"Isn't it borax?"

"I thought you wrote borax $Na_2B_4O_7$."

"Well, that's what I said. Na_2 before O_7."—*H. S. Johnson.*

NEEDS A SHOCK ABSORBER

DINER: "Waiter, what kind of meat is this?"

WAITER: "It is spring lamb, sir."

DINER: "I thought so! I've been chewing on one of the springs for an hour."—*L. Keiser Jr.,* Reporter No. 27612.

SOLELY

PROFESSOR (to inattentive pupils): "Is leather an organic or inorganic compound?"

PUPIL: "Er—inorganic."

PROFESSOR: "Then give me the chemical name."

PUPIL: "Ox hide of beef."—*Stanley Eastman.*

NOT A (S) MILE

MANUFACTURER to manager of a patent selling concern when shown an invention—"That sure is a far-fetched idea you have there."

THE MANAGER: "You're certainly right. This invention was brought from a small town in Siberia."—*Wilson G. Walters,* Reporter No. 6385.

MAKING LIGHT OF IT

PESSIMIST: "It's a hell of a heavy thunder storm."

OPTIMIST: "Yes, but don't you see it's lightning every minute."—*Leslie F. Carpenter.*

DON'T TELL MA

"Papa," asked little Willie, "why do they call it the 'mother tongue?'"

"Well," answered Father, "just see who uses it the most."—*L. Keiser, Jr.,* Reporter No. 27612.

HOW ABOUT MIC ROBE (?)

PROF. (in physics class): "What is a microfarad, Mr. Smith?"

MR. SMITH: "Well, I think it's about the same thing as a farad, only some people call it a microfarad because Faraday's first name was Michael."—*G. E. Davis.*

ROUND AND ROUND

REPORTER: "You believe the Flettner rotor is as powerful as an ordinary sail?"

MARINER: "Yes,—of course, in a roundabout way."—*J. Bront.*

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THE ORACLE

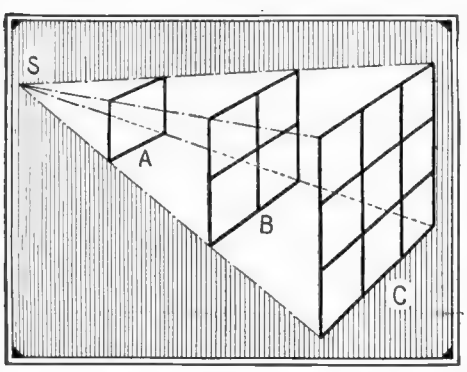
The "Oracle" is for the sole benefit of all scientific students. Questions will be answered here for the benefit of all but only matter of sufficient interest will be published. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink; no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addressed to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 50 cents is made for each question. If the questions entail considerable research work or intricate calculations, a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

INTENSITY OF LIGHT

(1952) Q. 1. Hubert Ross, Kansas City, Mo., asks: At what ratio does the intensity of light vary at distances from the source, the source being a theoretical point of light?

A. 1. The law governing this phenomenon of light states that the intensity of light varies inversely as the square of the distance. In other words, a source of light that will produce a given intensity at a given distance will give only one-



A diagram showing graphically how the intensity of light varies inversely as the square of the distance. S, A, B and C are equal distances apart.

quarter that intensity at twice the distance or one-ninth at three times the distance. This can be readily seen from our illustration given in these columns wherein, S, is the source of light and A, B and C are spaced at distances apart equal to that between S and square, A. It will be noted that the light from the source illuminates a square of the size shown at A, whereas it illuminates four such squares at B, and nine at C, so that a square of the size of A if at C receives only one-ninth the light.

INDUCTION—INDUCTANCE

(1953) Q. 1. Chas. F. Arthur, Derby, Conn., asks us to differentiate between the terms induction and inductance.

A. 1. The term induction specifically applies to the phenomena which takes place in current-bearing wires. The term inductance is sometimes used interchangeably with induction, although it is also used to specify a coil of wire, usually with an air core, and also in connection with values, to denote certain electrical properties of a coil of wire. The term induction is occasionally used in reference to spark coils which are sometimes termed induction coils.

RENEWING DRY CELLS

(1954) Q. 1. John J. Martin, Kansas City, Mo., mentions several methods which he has heard of regarding the renewing of dry cells and asks our opinion on them and directions for any other process that we may know of.

A. 1. There is no real good system for renewing dry cells. After they have once become run down, they can be given a short lease on life by charging or wetting down, but cannot be made as good as new. We do not believe that the method of heating that you mention would give any very good results. The only method which is fairly good is that of pouring a saturated solution of sal-ammoniac into the cell and allowing the depolarizer to absorb as much as possible. Do not, however, dry the cell by heat, but reseal as soon as the sal-ammoniac solution is absorbed. This is the best method, aside from that of leaving the cells with the zinc only drilled full of holes in a solution of sal-ammoniac.

In any event, good results will not be noticed when it is attempted to renew the life of a flash-light cell. The usual cause of a run-down cell in this case is a worn-out zinc element, whereupon, of course, it is impossible to revive the cell.

NEWTON'S LAW

(1955) Q. 1. James J. Silver, Portland, Me., asks: What are Newton's three laws of motion?

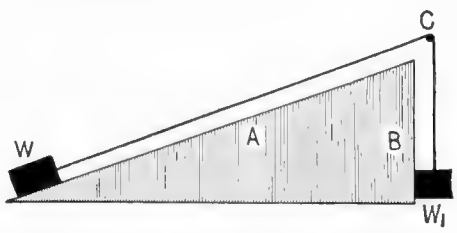
A. 1. Briefly stated, the laws are as follows:

1. Every body continues in its state of rest or of uniform motion in a straight line unless compelled by external forces to change that state.
2. The rate of change of momentum is proportional to the applied force and takes place in the direction in which the force acts.
3. To every action there is an equal and opposite reaction.

PERPETUAL MOTION

(1956) Q. 1. George Stevenson, Roscoe, N. Y., asks why perpetual motion is a fallacy and why it is considered to be a problem without a solution.

A. 1. The majority of perpetual motion machines are based upon fallacious reasoning. Practically all of them which depend upon revolution of a wheel or upon the rising and falling of weights do not take into consideration one certain fundamental fact that is illustrated graphically in these columns. That fact is that raising a weight to any given height requires the same amount of energy to be expended, regardless of how it is raised to the final position. Referring to the figure which we have simplified as far as possible, we have the proposition of raising the weights, W, and, WI, to the point, C. One weight can be drawn up the incline A, and the other raised vertically through the distance, B. It would seem offhand that the weight, W, could ascend the incline, A, with a smaller expenditure of energy than raising the weight, WI, directly to C. This is not the case, however, and neglect-



The above diagram aids in understanding why many perpetual motion machines will not operate.

ing friction in all phases of the proposition, we find that the same amount of energy must be expended in both cases. This line of reasoning can be applied directly or indirectly to practically every proposed form of revolving perpetual motion machine.

Unless some force is applied to the wheel or other device during one-half of its revolution, and then removed for the next half, devices of this nature cannot operate. It is physically impossible to apply and remove this force intermittently, as would be necessary to fulfill the conditions and, therefore, to date, it has been found impossible to construct devices of this nature. We are awaiting anxiously and skeptically the entry of some successful device operating by the force of gravity alone in our "Perpetual Motion Prize Contest." As yet, not one model has been submitted.

CENTRIFUGAL FORCE

(1957) Q. 1. Nick Daylantes, Chicago, Ill., asks: How is centrifugal force calculated?

A. 1. We are giving you below the formula necessary for the calculation of centrifugal force:

$$V = \frac{2\pi RN}{60}; \quad F = \frac{WV^2}{GR}$$

In the formula, R = the radius of the curved path in feet; F = the centrifugal force exerted upon the arm or cord connecting the body with the shaft; W = the weight of the body in pounds; N = the number of revolutions per minute; V = linear velocity of the center of gravity of the body in feet per second; G = 32.174.

HEAT-PROOF CEMENT

(1958) Q. 1. Fernand M. Yax, Scranton, Pa., says that he desires a material which can be placed in a position where it will be in contact with a red-hot wire for long periods of time, but which, when in use, will not be disturbed. He asks for a formula for a material of this nature.

A. 1. A simple material which can be used in the way you mention and which will give satisfactory results is some sort of an asbestos cement. Shredded asbestos mixed with fire clay and water glass to the desired consistency should be found quite satisfactory.

ELECTRIC TROLLEYS

(1959) Q. 1. A. Chapple, Nashton, B. C., Canada, asks why the electricity which operates trolley cars does not leak off into the earth, and why the ground around the rails of a trolley car system is not charged.

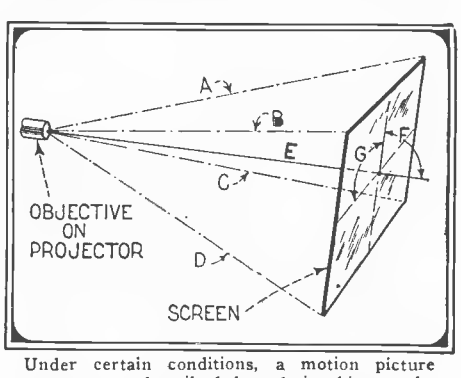
A. 1. The answer to your question on the trolley system is perfectly obvious if you will stop to consider that only one pole, or one side of the generator supplying the current is connected to the rails. Obviously, there can be no flow of current, except by the overhead trolley wire (which is connected to the other side of the generator) and the rails or the ground.

Of course, the ground around the rails might be considered to be charged, because, if it were in a damp condition and you were to stand thereon and touch the trolley wire with a metallic pole, you would receive a severe and possibly fatal shock.

MOVIE SCREEN

(1960) Q. 1. Raymond B. Williams, Pasadena, Calif., says that he is setting up a small theatre for private entertainments and has incorporated a small motion picture booth and motion picture screen in it. However, the booth is at some distance above the stage and when a picture is thrown from the machine upon a screen perpendicular to the stage, the result is a distorted image, wider at the bottom than at the top. He asks our assistance in correcting this fault.

A. 1. One trick of motion picture projection is to file the gate of the projection machine so as to compensate for the discrepancy on the screen. This, however, is not an advisable method as it does not always cure the distortion and, therefore, should not be relied upon. Probably the best solution to your problem is to change the position of the screen so that a line drawn through the center of it and perpendicular to its plane will be on



Under certain conditions, a motion picture screen must be tilted in relationship to the stage at an angle, determined by the line shown above.

the center line of the projection objective lens. This is clearly shown in our illustration herewith. The center line, E, is drawn so that the angles, F and G, are 90°, and the screen is tilted until this line strikes the objective on the projector as shown. When the screen is in this position, lines drawn from the lens to the four corners of the screen as at A, B, C and D, will be of equal length. We are sure that if you follow this procedure you will have no further trouble with distortion of pictures.

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METALLIC CLOTH

(1961) Q. 1. Edward Butts, Georgetown, Colo., asks us to describe a process whereby metallic copper may be precipitated from its salts upon cloth.

A. 1. Your problem of charging a piece of cloth with metallic copper is a peculiar one. If a copper salt such as the sulphate is treated with hypophosphorous acid or with a solution of sodium hypophosphite, copper hydride will be precipitated. If this is heated to 60° C. (140° F.) the hydrogen will be expelled and metallic copper will remain. The copper will be very finely divided.

Saturate your cloth with copper sulphate solution, dry it, immerse in, or better, distribute sodium hypophosphite over it with an atomizer and heat to above temperature. You will then have metallic copper all through the cloth.

This may answer your purpose; it is the best suggestion we can give.

Q. 2. How can gelatine be made insoluble?

A. 2. To make gelatine insoluble use potassium bichromate and expose to sunlight. Also try formaldehyde.

STORAGE BATTERY TROUBLE

(1962) Q. 1. E. H. Discher, Columbus, Miss., asks what causes a storage battery to lose its charge when standing idle.

A. 1. Your trouble is diagnosed as being an internal or self-discharge. You can readily detect it by a drop in voltage.

In order to verify this, see whether the battery will hold charge on standing idle, whether there are any impurities in the electrolyte, whether it gradually loses its current capacity, whether there is a drop in specific gravity, whether it is abnormally sulphated and if it gases while standing idle. Your troubles may be remedied by renewing the electrolyte, renewing defective separators, eliminating short circuits and keeping the battery clean, especially where the terminal and connection posts are made.

NATURAL STEAM

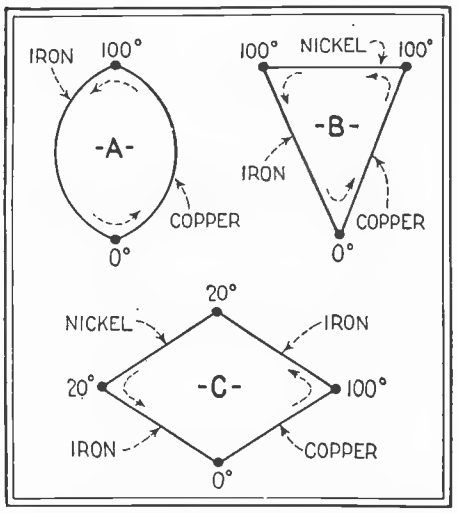
(1963) Q.1. John Hawkins, Cedarville, Calif., asks how the extraction of steam from natural sources is accomplished.

A. 1. Large pipes are driven into the ground at advantageous points near volcanoes or hot springs so that they tap underground rivers of hot water. The steam and vapor from the same is then conducted upward through the pipes and used for any purposes to which they can be put.

THERMOCOUPLES

(1964) Q. 1. James Malone, Stamford, Conn., asks: Does the introduction of a metallic wire or other circuit in that of a thermocouple make any difference in the actual operation of the couple?

A. 1. No, providing the terminals of the metal that is not one of the thermo elements, are at an equal temperature. Referring to the three small drawings herewith makes this clear. In all three circuits the electro-motive force is the same or on the order of .001 volts for a difference in temperature of 100° C-(212°F) between the hot and cold junctions. In Fig. A, only iron and copper are used with the usual result. In Fig. B, a length of nickel wire has been introduced into the circuit and when its terminals are at the same



Thermocouples operate just as well with a third metal in the circuit, providing the terminals of that metal are at equal temperatures. More details on the three figures shown above will be found in the text.

temperature, in this instance 100°C., the E.M.F. in the circuit is the same as in Fig. A. In Fig. C, the nickel wire is at another point in the circuit, distant from the 100° junction. Its terminals are at a temperature of 20° each, but the result is still the same. The circuit will deliver the same E.M.F. as Fig. A.

CARBON PAPER

(1965) Q. 1. D. B. Baskerville, Salem, Va., asks for some details on carbon or duplicating papers.

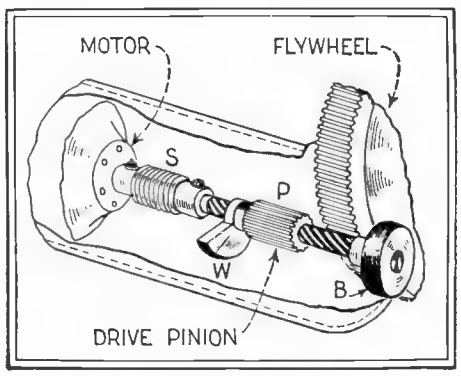
A. 1. Many carbon papers act by virtue of a detachable pigment, which, when the pigmented paper is placed between two sheets of white paper, and when the uppermost paper is written on, transfers its pigment to the lower sheet along lines which correspond to those traced on the upper paper and, therefore, gives an exact copy of them on the lower sheet.

The pigments used are fine soot or ivory black, indigo carmine, ultramarine, and Paris blue, or mixtures of them, and various others. The pigment is intimately mixed with grain soap and then rubbed onto thin but strong paper with a stiff brush. Fatty oils, such as linseed or castor oil, may be used, but the grain soap is preferable. Graphite is frequently used for black copying paper. It is rubbed into the paper with a cotton pad until a uniform light-gray color results. All superfluous graphite is then carefully brushed off.

BENDIX DRIVE

(1966) Q. 1. Adolph Peters, Orange, Texas, asks how the Bendix drive, which connects the starting motor of an automobile engine with the fly-wheel, operates.

A. 1. We illustrate herewith and describe below the exact operation of this device. It acts on the principle of inertia. When the starting motor is actuated by means of the storage battery, the inertia of the weight W causes it and the pinion P to travel forward along the triple thread screw called the lead screw. The ends of the pinion teeth and the teeth on the fly-wheel are beveled so that they can mesh easily. The inertia serves to engage them firmly, whereupon the starting motor turns the fly-wheel and consequently turns the engine until it starts. Immediately that this happens, the direction of the driving force is reversed and instead of the pinion



A diagram of a standard Bendix gear for automobile starting motors is shown above and described in this column.

driving the fly-wheel, the fly-wheel drives the pinion. Therefore, the pinion is thrown out of mesh with the fly-wheel. The bearing, B, serves to steady the entire assembly and the spring, S, permits some play to take place between the motor shaft and the lead screw. It thus takes up the shock which naturally takes place when the gears engage.

GAS PRESSURE

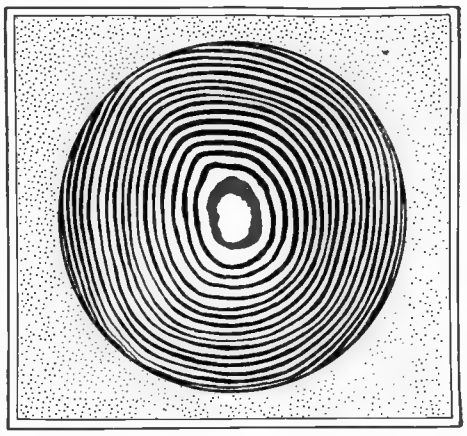
(1967) Q. 1. F. R. Kiedinger, New Orleans, La., asks: If I have one cubic foot of air compressed to 100 pounds per inch at a temperature of 50° Centigrade, how many cubic feet of air will result if the temperature is raised to 100° C, presuming that the air is kept at a constant pressure of 100 pounds?

A. 1. The answer to this query depends upon Charles' law of gases and the absolute temperature scale. The latter, for any degree Centigrade can be obtained by adding that figure to 273. The initial pressure of the gas has no bearing upon the result in this particular calculation and the formula used $\frac{V}{T} = \frac{VI}{TI}$. Here T is equal to 273 plus the initial temperature and TI is equal to 273 plus the final temperature. V equals the starting volume. In your particular problem, the air under a constant pressure will expand so as to occupy 1.15 cubic feet. The figures representing T and TI are known as the absolute temperatures.

NEPTUNE

(1968) Q. 1. Joseph Caverson, West New York, N. J., has been told that the planet Neptune cannot be seen with the naked eye and that it was discovered by calculation. He asks if this is true.

A. 1. Yes, this is entirely true. The planet Neptune is 2,800,000,000 miles distant from the sun and takes 164 earth years to travel around that heavenly body. The planet was first discovered by calculation and these calculations were started by observations of the planet Uranus which did not move in accordance with the predictions made by astronomers. Many prominent men connected with this work investigated the reasons for the erratic movements of Uranus and by means of a series of calculations spread over a period of years, they reached the conclusion that an unknown heavenly body was present in a certain position. A search with telescopes was made, and within half an hour the new planet was discovered in almost its exact calculated position. This took place on September 23, 1846, and the credit goes to John C. Adams, an Englishman, and Urbane Leverrier, a Frenchman.



Newton's rings formed as described here take the appearance illustrated above. Note the gradations of widths of the rings.

NEWTON'S RINGS

(1969) Q. 1. Richard Fleischer, Miami, Fla., asks: What are Newton's rings?

A. 1. These rings are formed when a convex lens of very large radius of curvature is placed in contact with a flat plate and the combination is illuminated by any light. With a so-called monochromatic light, such as the sodium light, the surface of the circular area between the slightly curved lens and the glass plate will be seen to be covered with alternate dark and bright concentric rings. If a white light is used, colored rings will be seen surrounding the point of contact between the lens and the plate. These rings will correspond to definite thicknesses of the air film. The illustration herewith shows the appearance of Newton's rings viewed under sodium light. They are due to interference of light.

CASEIN

(1970) Q. 1. A. Hering, Brooklyn, N. Y., asks us to tell him what part of the milk adheres to the walls of the pot when milk is boiled, and wants to know how this can be avoided.

A. 1. When milk is boiled, the casein contained therein adheres to the walls of the pot. This cannot be prevented.

POWDER FIRE EXTINGUISHERS

(1971) Q. 1. A. Yust, San Francisco, Calif., asks about the efficiency of fire extinguishing powders and also for formulas for the same.

A. 1. The efficiency of various powder fire extinguishers is questioned by some authorities. We give you herewith two formulas for making up powder fire extinguishers, but cannot guarantee them. You should test them before placing too much faith in their fire-extinguishing abilities:

No. 1

Alum	24 parts
Ammonium Sulphate	52 parts
Ferrous Sulphate	4 parts

No. 2

Sodium Chloride	6 parts
Ammonium Chloride	6 parts
Sodium Bicharbonate	8 parts

Fine sand or earth also make excellent extinguishers for gasoline and oil fires.

CLEANING COPPER

(1972) Q. 1. W. C. Albers, Chicago, Ill., asks: Can you tell me one or two good methods for cleaning the black coating from copper surfaces? This is for use in cleaning the copper tub in a washing machine that becomes black due to a continued action of soap upon it.

A. 1. Hot caustic soda should readily remove the black coating of dirt on the copper tubs. You must remember that caustic soda is injurious to the hands and must be used with extreme care. Try household ammonia but wash out every trace of it with clean water.

Another way in which to clean this would be to use wool grease, 46 parts by weight, fire clay, 30 parts, paraffin, 5 parts, Canova wax, 5 parts, cocoanut oil, 1 part and 1 part oil of Mirbane. After mixing these definite ingredients which constitute a paste, this is molded in order to give a cylindrical form and introduced into a case so that it can be used like a stick of cosmetic. This paste is not injurious to the hands, but "elbow grease" must be used in order to get the dirt off. You might try vinegar and salt or vinegar and oxalic acid after which you must wash the tub thoroughly and polish with sweet oil.

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$15,227.00

PAID BY

SCIENCE and INVENTION Magazine

During the Past Year

THIS issue brings to a close the second fiscal year of SCIENCE AND INVENTION Magazine's monthly prize contest. During the year of 1924 SCIENCE AND INVENTION paid the sum of $13,320.00 to 1,112 prize winners. These prize winners submitted articles to this publication, and when published were awarded prizes by the judges in accordance with the $1,000.00 monthly contest.

During the past year this publication has paid $15,227.00 for articles alone appearing in this magazine. This figure is exclusive of a great many special prize contests which this magazine is still offering. For instance, the $11,000.00 prize contest for proofs of psychical phenomena has not yet been collected. Consequently this prize contest is still open. Those attempting to compete for awards must demonstrate their ability to produce any sort of a psychical phenomenon. These are outlined in the rules. Joseph F. Rinn and SCIENCE AND INVENTION Magazine have brought the total amount for the awards up to $11,000.00 for such proofs.

Then there is the Perpetual Motion prize contest offering $5,000.00 in awards. This likewise has not been collected, nor has anyone sent a working model of a perpetual motion machine to these offices. We merely desire the privilege of examining the machine, and will return it to its inventor and will pay him $5,000.00 on condition that his machine is a perpetual motion device. This prize offer is made merely to protect the many investors who would like to place money in perpetual motion machine stock.

And now we come to another prize contest—the banner feature of the year. This is the $5,000.00 prize contest announced elsewhere in this issue for models built entirely of matches. The article speaks for itself and you, your friends, your colleagues, your daughters, your sons or school pals may try for the prizes. The editors advise that you look through this issue and read about this interesting pastime, which has already taken the country by storm.

In order to make room for more text this page of prize announcements published monthly will be discontinued, and the new prize announcements will be published from time to time elsewhere in the magazine.

Beginning with the January issue SCIENCE AND INVENTION will pay a regular rate of two cents a word for material accepted and published. Photographs will be paid for at a rate of $2.00 apiece for all those accepted and published. Special articles will be paid for at special rates. The editors, of course, reserve the right to increase the rate for any articles of particular worth.

$1000.00 Monthly Contest Awards

FIRST PRIZE $100.00

New Rescuing Methods for Submarinists, by F. W. Horton 718

SECOND PRIZE $75.00

How Movie Railroad Wrecks Are Made, by Frank George Kerk 723

TWO PRIZES OF $50.00 EACH

Trick Photography in "The Gold Rush," by Edwin Schallert 714
The Strength of Insects, by Dr. Ernest Bade 716

THREE PRIZES OF $35.00 EACH

Science in Prison Escapes, by Joseph Fulling Fishman 707
Electric Fountains Float in the River Seine, by A. N. Mirzaoff 709
A Novel Audio Frequency Amplifier, by R. L. Young 743

FIVE PRIZES OF $25.00 EACH

Bridge Is Great Engineering Feat, by A. N. Mirzaoff 706
New Fruits, by A. N. Mirzaoff 711
Mineral and Oil Finder, by H. T. Wilkins 722
Finding the Center of Gravity by Experiment, by C. A. Oldroyd, Reporter No. 4433 730
Shadow Pictures, by N. C. Everett 731

FIVE PRIZES OF $20.00 EACH

Mathematical Cross-Number Puzzle, by Richard H. Tingley 728
Pocket Metronome, by Dr. Russell G. Harris 729
Sound Gauge, by C. A. Oldroyd, Reporter No. 4433 729
Hygroscopic Motor, by Emile Dion 731
Automatic Storage Battery Filler, by J. Bront 777

TEN PRIZES OF $15.00 EACH

Novel Sun Clock, by Ernest Brennecke, Jr. 717
Window Control, by Edward L. Salmon 729
An Air Flame, by C. A. Oldroyd, Reporter No. 4433 731
Pigeon Trap, by John Kautzner 731
Book Marker, by T. B. Marsden, Jr. 732
Sun Clock, by Francis O. Boyd 732
Rain Alarm, by C. A. Oldroyd, Reporter No. 4433 732
Bottle Filler (author please send address) 732
Multiple Detector, by G. A. Luers 775
Magnifying Readings, by A. E. Jones 775

FIFTEEN PRIZES OF $10.00 EACH

Boxing Gloves, by Walter Schwartzmiller 732
Pipe Repair, by Donald Bowie, Jr., Reporter No. 22261 732
Graduate Protector, by A. Eidman 732
Hero's Fountain, by A. A. Blumenfeld 732
Pole Indicator, by F. J. Wilhelm 734
Memo Pad, by Leo Preston 734
Panel Repair, by Wilton F. Swatch 734
Magnetic Broom, by E. L. Dunbar 734
Nailing Thin Wood, by Max Ruschmann 734
Ring Stand, by Jesse Walters 734
Switch, by Robert Aaron 777
Screw Driver, by J. E. Tewksburg 777

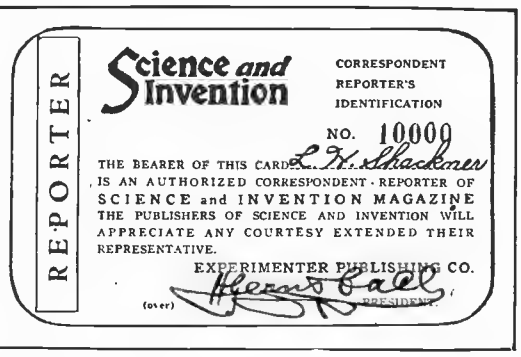
(No further entries)

Other Pending Contests — $100.00 in prizes awarded for uses of old photographic films. Contest announced in the November, 1925, issue and closes December 30, 1925.

$31,000.00 In Prizes Has Been Paid By SCIENCE AND INVENTION MAGAZINE

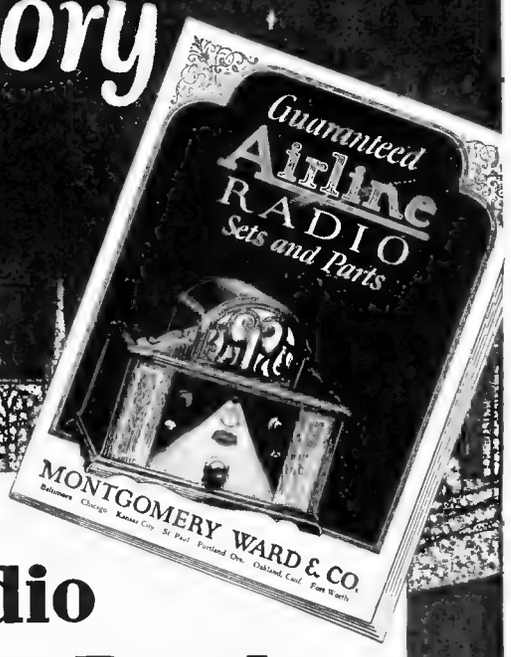
During the past two years SCIENCE AND INVENTION Magazine has paid more than $31,000.00 to its contributors and correspondent reporters. During the past year $15,227.00 has been paid. This magazine now has more than 28,000 reporters in the field. The prizes won by reporters during the past year will be greatly augmented during the coming year, judging by all appearances. Consider the fact that the year 1926 is opening with prize contests totaling $21,100.00 and no consideration is made of the moneys to be paid to contributors, and no one knows what additional prizes are to be offered our readers during the year.

In order to assist our contributors in obtaining material for this publication, we are still issuing "Reporter" cards. These may be obtained without charge. A sample of our reporter's card is illustrated at the right. If any of our readers desire one, they may secure the same by simply sending a postal card making the request. Address the card to Field Editor, SCIENCE AND INVENTION Magazine, 53 Park Place, New York City.



(Note—Unavailable material not accompanied by postage will not be returned.)

The World's Greatest Radio Story



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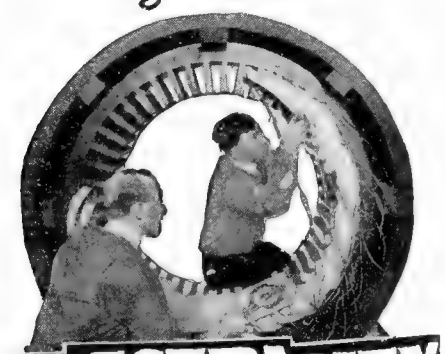

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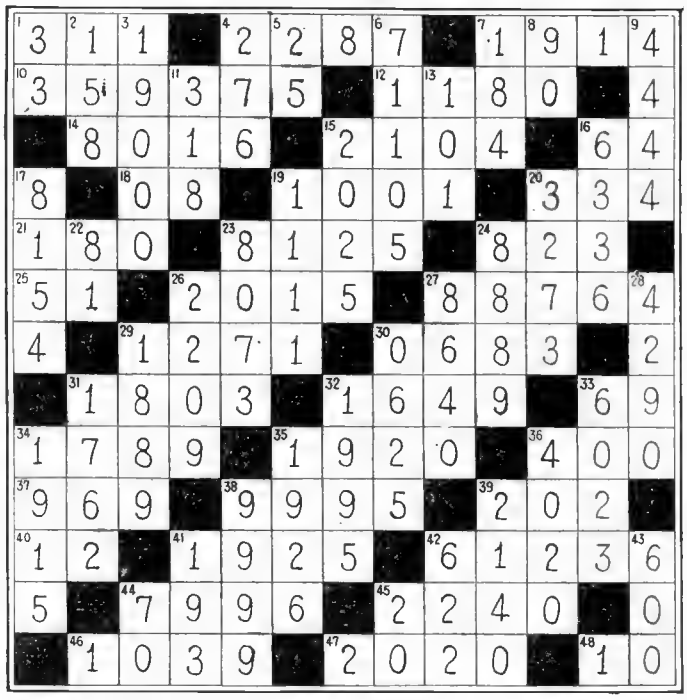
*Address*_____

Answers to Cross Number Puzzle

(*Continued from page 728*)

ANSWERS
HORIZONTAL

1—$\sqrt{1925} \div 4 = 12.44 \div 4 = 3.11$
4—138 × 16.5 = 2277 + 10=2287
7—1914
10—$\frac{23}{64} = 23 \div 64 = .359375$
12—$\sqrt{1643} = 11.80$
14—668 × 12=8016
15—13^3=2197—93 = 2104
16—8 × 8 = 64
18—$\sqrt{.0064} = .08$
19—MI = 1001
20—334
21—180
23—$\frac{52}{64} = 52 \div 64 = \frac{8125}{}$
24—29^2 = 841—18=823
25—LI = 51
26—2015 World Almanac
27—384 × 231 = 88704 + 60 = 88764
29—1925 -654=1271
30—$\sqrt{.25} = .0625 + .0058 = .0683$
31—MDCCCIII = 1803
32—CCLXXVI = 276 : 1925—276 =1649
33—69 World Almanac
34—1789
35—1920
36—"Charge of the Light Brigade" —400 Tennyson*
37—969 Genesis V — 27
38—10000 — 5 = 9995
39—CII = 202
40—12
41—1925
42—5280×10= 52800
2812× 3= 8436
61236
44—39.37 × 203 = 7992+4 = 7996
45—2240



46—1775—736=1039
47—1925+95=2020
48—The maiden's name was IO

VERTICAL

1—22/40ths of 60=33
2—13^2=169 — 11=158
3—MCM = 1900×10 = 19000
4—276
5—5^2 = 25
6—2000 × 35.5525 =71105
7—184
8—9
9—IV. IV. IV. IV. =4444
11—53×6 = 318
13—CI=101
15—$.45^2$ = .2025
16—396 × 16=6336
17—43560 × .1872=8154
19—1066+45=1111
20—$32.73 — From tables
22—3×27=81
23—299×27=8073
24—$.8889—From tables
26—47^2 = 2209
27—320 × 27 = 8640
28—$\sqrt{1840} = 42.90
29—14×128 = 1792 +97 = 1889
30—4/64ths = 4 ÷ 64 = .0625
31—106.79 × 16.5= 1762
32—1925+70 = 1995
33—47 × 128=6016 +7=6023
34—1915
35—19.26—From tables
36—.4020
38—IX. IX. IX. IX. =9999
39—2240 — 100 = 2140
40—19.3 cents
42—622
43—50×12=600
44—IX^2=81
XI =$\frac{11}{70}$
45—20 From tables

*Eraatum. Correct number is 600.

Refrigerated Theatres

(*Continued from page 713*)

ence as regards the transmission of colds or other disease germs.

As will be seen from the accompanying drawing by Mr. Wall, one section of blowers and water sprayers on the roof take care of the air which is blown down through the openings in the ceiling of the auditorium, while another section of blowers and sprayers take care of the air blown through the openings in the proscenium arch.

This same air circulation system is well adapted for winter-time heating and ventilating, and in this case the carbon dioxide cooling plant in the basement is not used. The circulating fans on the roof and the water sprayers are used to wash the air and properly humidify it, and in connection with this part of the circulating scheme, steam heat is provided in the air conditioning chambers, so that warm air of the correct temperature and humidiy is blown out through the openings in the ceiling and proscenium arch.

Most of the information given and the opportunity for our artist to inspect the plant thoroughly is due to the courtesy of Mr. George O'Day, chief engineer of the Capitol Theatre. It is interesting to remark in closing that the carbon dioxide gas used in operating this huge cooling plant is particularly well adapted for its important role, due to the fact that it is colorless, odorless, tasteless, non-poisonous and is also very effective as a fire extinguishing medium. The engineers who installed the apparatus also state that mechanical refrigeration helps to eliminate excess moisture from the air, and thus what was once a dream of the progressive theatre manager has come to be a real live actuality; namely, "*twenty degrees cooler than the street.*" If you don't believe it, try it!

THE LATEST HOBBY
$5,000.00 For Models

Models made of match sticks are simple in construction, inexpensive to make and may win for you part of the $5,000.00 that SCIENCE AND INVENTION Magazine is offering for this work. See the article in this issue for full and complete details.

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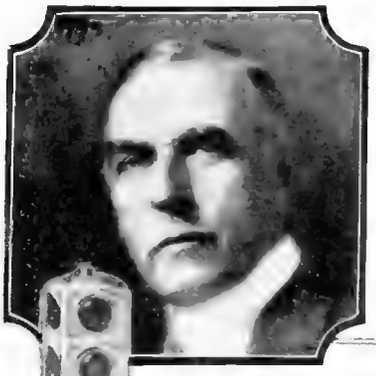

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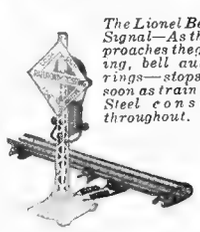

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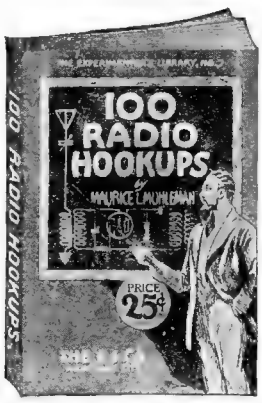

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Tarrano the Conqueror

(*Continued from page 725*)

"I would like to have you very much, indeed." She added to Tarrano, and there was on her face a look of feminine guile:

"You, of course, could not refuse me so small a favor? After all your protestations——"

He gestured impatiently. "Very well." And he added to Tara: "You will serve the Lady Elza as she directs."

He stalked away into the darkened passage. In the gloom there, he stopped and again faced us; the light from a small blue tube in there illumined him dimly. He was smiling ironically.

"I shall maintain the instruments for you. The mirrors will show you Georg and Maida. They are just about arriving at the Mountain Station. Watch them! You will see how far they progress with their wonderful speeches."

He left us. We heard his measured tread as he stalked down the tower incline. The barrage about the tower was lifted momentarily as he went out. Then it came on again, with its glow beyond our casements, and its low electrical whine.

ELZA IN DANGER

I was just turning back to the room when a sound behind me made me face sharply about. My heart leaped into my throat. The woman Tara had produced from about her person a weapon of some kind. She thought she was unobserved, but from the angle at which I stood, I saw her. A gleaming metal object was in her hand. And then she launched it—a small flat disc of metal, thin, and with its circular edge keen as a knife-blade.

Whirling with a very soft hum hardly audible, it left her hand and floated upward across the room. Circling the casements up near the ceiling, and then heading downward straight for Elza! And I saw, too, that the woman was guiding it by a tiny radio-control at her girdle.

The thing was so unexpected that I stood gaping. But only for an instant. I saw the deadly whirling knife-disc sailing for Elza . . . It would strike her . . . shear her white throat. . . .

With a shout of horror and anger, I leaped for the woman. But Wolfgar, too, had seen the disc; and he resumed and acted better than I. The divan was beside him. He snatched up a pillow: flung it upward at the disc. The soft pillow struck the disc; together, entangled, they fell harmlessly to the floor.

I was upon the woman, snatching the handle of the control-wire from her hand, wrenching its connection loose from her robe. Under my onslaught, she fell; and I kneeled beside her, gripping her while she tore at me and screamed with hysterical, murderous frenzy.

CHAPTER XIII

LOVE—AND HATE

I did not harm this Tara, though I was sorely tempted to; and after a moment we quieted her. She was crying and laughing by turns; but when we seated her on the divan she controlled herself and fell into a sullen silence. Elza, pale and frightened at her escape, faced the woman, and waved Wolfgar and me aside. Strange little Elza! Resolute, she stood there, and would brook no interference with her purpose. Wolfgar and I withdrew a pace or two and stood watching them.

Tara's breast was heaving with her pent emotion. She sat drooping on the divan, her face buried in her hands.

Elza said gently: "Why did you do that, Tara?"

There was no answer; only the woman's catching breath as she struggled with her sobs. Across the background of my consciousness came the thought that Tarrano or one of his guards would doubtless momentarily appear to investigate all this turmoil. And I was vaguely conscious also that from our instrument room the sounds of an unusual activity were coming. But I did not heed them. Elza was insisting:

"Why did you do that, Tara? Why should you want to harm me?"

Tara looked up. "You have stolen the man I love."

"I?"

"Yes. Tarrano——"

She broke off, set her lips firmly together as though to repress further words; and her fine grey eyes, filled with unbidden tears, were smoldering to their depths with hate.

Impulsively Elza sank to the floor beside the woman. But Tara drew away.

Elza said: "Tarrano—he is a wonderful man, Tara. A genius—the greatest figure of these three worlds. . . ."

My heart sank to hear her say it!

". . . a genius, Tara. You should be proud to love him. . . ."

"You——" The woman's writhing fingers seemed about to reach for Elza. I took a sudden step forward, then relaxed. Elza added quickly:

"But I would not steal Tarrano from you. Don't you realize that?"

"No!"

"But it's true."

"No! No! You have stolen him! With your queer Earth-beauty—that colored hair of yours—those rounded limbs—you've bewitched him! I can see it. You can't lie to me! I made him angry once and he admitted it."

"No. I tell you!"

"I say yes. You've stolen him from me. He loves you—and he mocks and laughs at me——"

"Tara, wait. I do not love Tarrano. I tell you. I would not have him——" How my heart leaped to hear her say it so convincingly. She added:

"He loves me, perhaps—but I can't help that. He has me prisoner here. I am forced——"

"You lie! You are playing to win him! What girl would refuse? You say yourself he is the greatest man of the ages. You lie when you tell me you do not want him!"

Elza had taken the woman by the shoulders. "Tara, listen—you *must* listen! Are you mated with Tarrano?"

"No! But years ago he promised me. I took his name then, as we do in the Cold Country. They still call me Tara! Years I have waited, true to my promise—with even my name of maidenhood relinquished. *His* name—Tara! And now he tosses me aside—because *you*, only an Earth-woman, have bewitched him."

"I didn't want to bewitch him, Tara." Elza's voice was very gentle; and a whimsical smile was plucking at her lips. "You think I want him because he is a genius—the greatest man of our time?"

"Yes!"

"Is that why *you* want him?"

"No, I love him."

"You loved him before he was very great, didn't you?"

"Yes. Back in the Cold Country. When he was only a boy—and I was no more than a girl half grown. I love him for himself, I tell you——"

Elza interrupted; and her voice risen to greater firmness, held a quality of earnest pleading.

(*Continued on page 756*)

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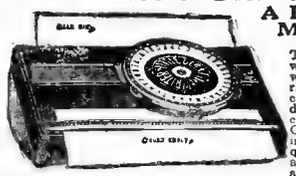

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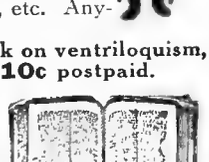

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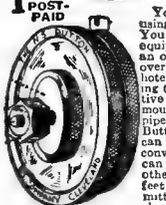

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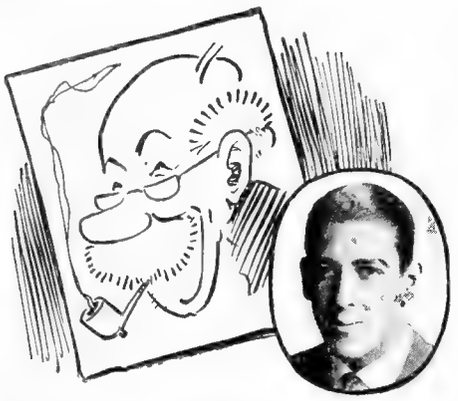

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Tarrano the Conqueror

(*Continued from page* 754)

"Wait, Tara! You love Tarrano for himself—because you are a woman capable of love. It is the man you love—not his deeds, or his fame or his destiny. Isn't that so?"

"Yes. I——"

"Then won't you give me credit for being a woman with instincts as fine as your own? The love of a good woman goes unbidden. You can't win it by conquering worlds and flinging them at her feet. Tarrano thinks you can. He thinks to dazzle me with his feats of prowess. He wants to buy my love with thrones for me to grace as queen. He thinks my awe and fear of him are love. He thinks a woman's love is born of respect, and admiration, and promises of wealth. But you and I, Tara—we know it isn't. We know it's born of a glance—born in poverty and sickness—adversity—every ill circumstance—born without reason—for no reason at all. Just born! And if anything else gives it birth—it is not a true woman's love. You and I know that, Tara. Don't you see?"

Tara was sobbing unrestrainedly now, and Elza, with arms around her, went on:

"You should be proud to love Tarrano. If I loved him, I would be proud of him, too. But I do not——"

A step sounded near at hand. Tarrano stood in the archway, with arms folded, regarding us sardonically.

CHAPTER XIV

DEFYING THE WORLDS

"So?" Tarrano eyed us, evidently in no hurry to speak further, seemingly amused at our confusion. Had he heard much of what the two women had said? All of it, or most of it, doubtless, with his instruments as he approached. But, even with the knowledge of Elza's vehement appraisal of him, he seemed now quite imperturbable. His gaze touched me and Wolfgar, then returned to the women.

"So? It would seem, Tara, that your plan to wait upon the Lady Elza was not very successful." He dropped the irony, adding crisply: "Tara, come here!"

She rose to her feet obediently, and stood facing him. Humble, fearful, yet a trifle defiant. For a moment he frowned upon her thoughtfully; then he said to Elza:

"Your policy of mercy is very embarrassing, Lady Elza." He made a deprecating gesture, and again his eyes were twinkling. "This woman threatened your life. My guards were lax—though I must admit they had good excuse, with the other tasks which I thrust upon them. . . . Your life was threatened—you escaped by the merest chance of fortune. You know, of course, what justice would bid me do to this intending murderess?"

Elza was on her feet, standing beside Tara. She did not answer.

Tarrano now was smiling. "I must let her go unpunished? Embarrassing, this merciful policy to which you have committed me! Yet—your will is my law as you know—though I feel that some day it will involve us in disaster. . . . You, Tara, will not be punished, much as you deserve it." He paused, then said as an afterthought: "You Jac Hallen, I thank you for what you tried to do in thwarting the attack. You acted in very clumsy fashion—but, at least, you doubtless did your best." Gravely he turned to Wolfgar. "I shall not forget, Wolfgar, that, in an emergency, you saved the life of Lady Elza. . . . Enough! These are busy moments. You chose an awkward time to raise this turmoil. Come with me—all of you."

(*Continued on page* 758)

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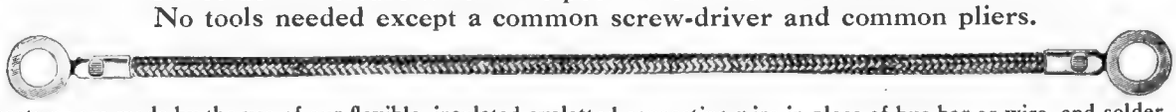

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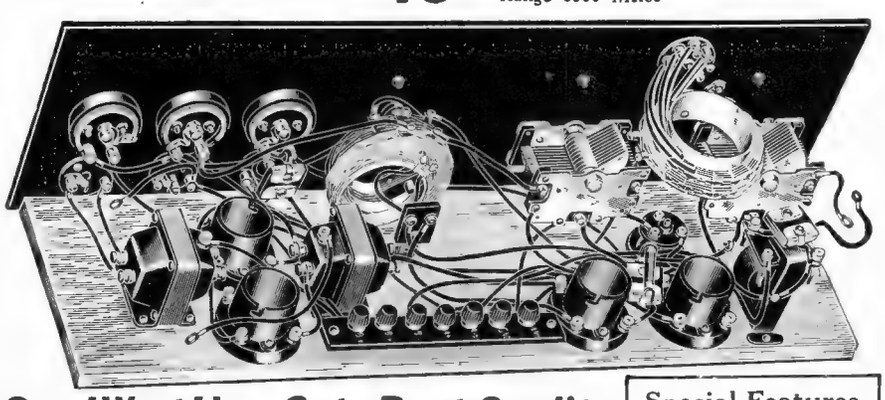

See what Doubleday, Page & Co., through Mr. Arthur H. Lynch, Editor of their magazine, "Radio Broadcast," say about the Radio Broadcast's sensational 4-Tube Knock-Out Set developed by Walter Van B. Roberts:

"Tube for tube, dollar for dollar, result for result, we will stack it up against any receiver for home construction ever described by any radio publication and gamble that it comes out winner."

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Receives Calif. from N. Y. on Two Tubes!

"I have followed the development of the Roberts circuit with results far beyond all expectations. I find it to be EXACTLY as efficient as described, although I was skeptical as to the unusual operation that it was said to have accomplished. I no longer have any doubts, for in the last week of August and to date in September, I have received KGO at least four times. On one of these occasions I received it on my Dictograd loud speaker, using only two tubes! I have consistently received long distance, such as Dallas, Fort Worth, Auburn, La., Hastings, and Kansas City, in all about 65 stations, while just "fishing." Locals, such as Pittsburgh, Schenectady, New York City, Chicago, Boston, etc., it need not be mentioned, are perfect, even on occasions when I have used neither aerial nor ground. I am sure it was a lucky day when this set came to my attention." L. L. Clifford, 190 Second Street, Fulton, NEW YORK.

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It offers a better combination of sensitivity, selectivity and quality for the total cost than any other circuit we have ever known.
The best 4-Tube set for home construction ever produced.

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By one of the editors of "Radio News"

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WEAF	86	77	N. Y. City
WFBH	65	21	N. Y. City
WFAM	55	18	St. Cloud, Minn.
WQAO	73	40	N. Y. City
WEBH	75	13	Chicago
WJY	72	52	N. Y. City
KDKA	70	32	E. Pittsburgh, Pa.
WTAS	67	25	Elgin, Ill.
WGBS	67	30	N. Y. City
WHN	72	39	N. Y. City
WJAX	88	48	Cleveland
WIT	75	83	Philadelphia, Pa.
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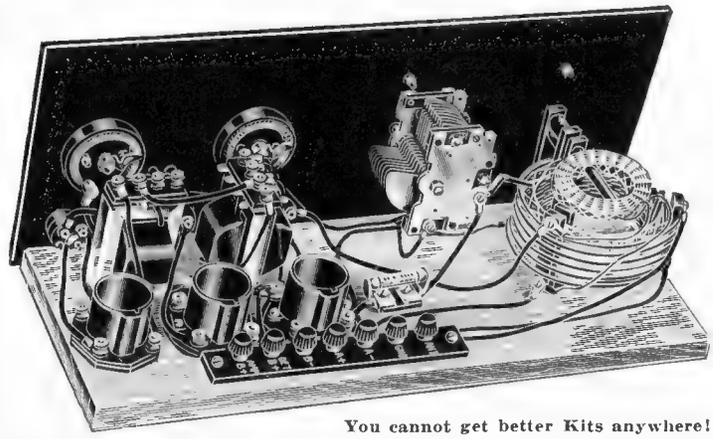

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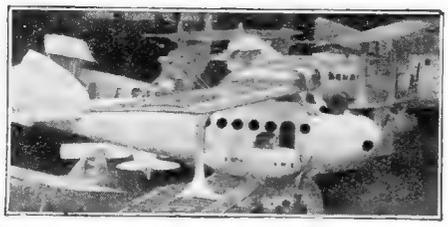

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Tarrano the Conqueror

(*Continued from page 756*)

He summoned Argo and two other guards. Unceremoniously, and with more haste than I had ever seen in Tarrano, he led us from the building. A hint of his purpose came to me, as he bade Elza gather up her few personal belongings, and gave them to a guard to carry.

In a group, he herded us across the spider bridge. It was early evening, but night had fully fallen. The city was ablaze with its colored lights. We crossed the bridge, passed through a tunnel-arcade, and came out to a platform which was at the base of a skeleton tower. Its naked girders rose some seven hundred feet above us. The highest structure in the city. A waiting lifting-car was there. We entered, and it shot us upward.

At the top, the narrowed structure was enclosed into a single room some thirty feet square. A many-windowed room, with a small metal balcony surrounding it outside. Immediately above the room, at the very peak of the tower, was a single, powerful light-beam; its silver searching ray swept the cloudless, starry sky in a slow circle.

The room was crowded with instruments. Unlighted, save by the reflected glow of its many image-mirrors, all of which seemed in full operation. A dozen intent men sat at the tables; a silent room, but for the hum and click of the instruments.

Tarrano said softly: "We have been very busy while you below were engaged with your petty hates and jealousies."

He seated himself at a table apart, upon which was a single mirror, and he gathered us around him. The mirror was dark. He called:

IN TOUCH WITH MARS

"Rax—let me see Mars—you have them by relay? The Hill City?"

The mirror flashed on. From an aperture overhead, a tiny beam of the blue heliotransformer came down to it. In the mirror I saw an image of the familiar Hill City. A terraced slope, dotted with the cubical buildings, spires and tunnel mouths. An empty channel* curved down across the landscape from the north.

A distant scene, empty and lifeless save for black puffs which rose in the air above the city.

Tarrano called impatiently: "Closer, Rax!"

The image dissolved, blurred; turned red, violet, then white. We seemed now upon a height close above the city. It was seething with confusion. Fighting going on in the streets. Animals and men, fighting; a crowd of the Little People thronging a public square, with beasts of war charging them.

The Hairless Men! I had heard of them, with their animals trained to fight, while they—the humans—lurked behind. A mysterious, almost grewsome race, to us who live on Earth—these hairless dwellers of the underground Mars. Dead-white of skin; sleek and hairless; heavily muscled from the work of their world; and almost blind from living in the dark.

They were swarming now into the Hill City of the ruling Little People. The beasts, at their commands, were running wild through the streets . . . dripping jaws, tearing at the women . . the children. . . .

I felt Elza turn away, shuddering.

Tarrano chuckled. "The revolt. It came, of course, as I planned. This Little People government—it was annoying . . . Colley!"

(*Continued on page 762*)

*Canal, as it now is thought to be.

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PRICE per set—No. 701.....$3.00

HAND DRILL

The hardwood handle is hollow to store drills. Iron frame, nickeled parts, ball bearing three jawed chuck holding and centering accurately round shank drills from 0 to 3-16. Length of drill, 12 inches.
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For making eyes, loops, bends, and offsets on Bus Bar wire. With this device any Radio Constructor can wire his set to compare favorably with any factory made set. Easier to use and more accurate than pliers. Full directions in box. Made of heavy steel, blued and finished.
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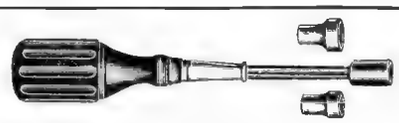
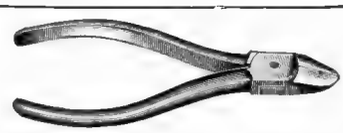
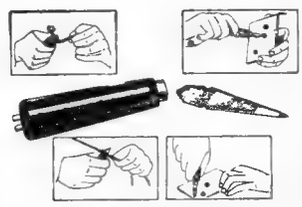
PRICE—No. 302 .....$2.75



Three-in-One Nut Wrench. Consists of handle with hollow stem 6 inches in length and three interchangeable sockets fitting popular sizes of nuts. The hexagon sockets grip the nut solidly.
PRICE per set—No. 301.....65c



Side Cutting Nipper, Lap Joint. For cutting all kinds of wire. Jaws hardened and oil tempered. Natural steel finish with polished jaws. Length 6 inches.
PRICE—No. 201 .....75c

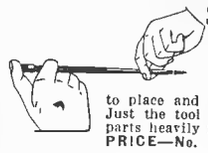


RADIO HANDI-TOOL

Bends Bus Bar or wire strips and scrapes wire, bores and reams holes, etc. Tool consists of 4 in. black japanned handle, to which is attached wire bending device, with nickeled ferrule and 3 in. long two sided reamer.
PRICE—No. 702 .....50c

TOOL CHEST

Set consists of "LOCK-GRIP" master handle, 5" long, black Rubberoid finish with steel chuck, nickel plated, buffed and with the following 9 tools: Saw, brad-awl, large screwdriver, file, scratch awl, gimlet, reamer, chisel, small screwdriver. Each tool of fine steel, drop forged tempered, hardened, and nicely finished. Set comes in leatheroid box with tray.
PRICE—No. 703 .....$1.85



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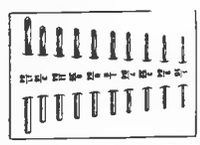

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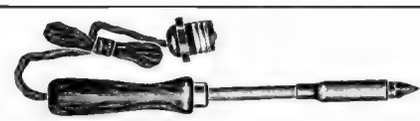

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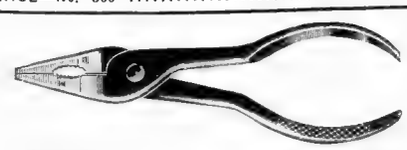

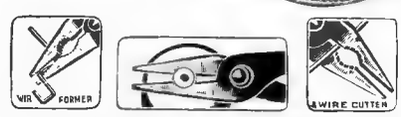

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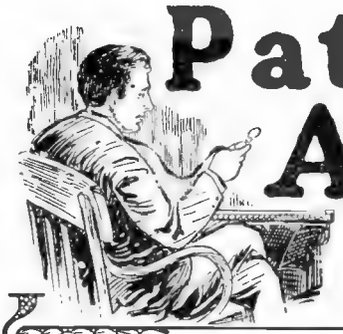

Edited By
A. P. PECK

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WINDOW PROTECTOR

(918) Benjamin Wolfield, New York City, has designed a device for the protection of jewelers' show windows. He desires to know whether or not we think that the same is worthy of a patent.

A. 1. There are many devices upon the market for protecting jewelers' show windows. We do not advise your attempting to patent anything of this nature, as its marketing possibilities are practically nil.

Nearly all jewelers are insured against theft and fire, and the protection of which you speak would not prevent burglary, nor would it materially decrease the insurance rates. Consequently, very few jewelers would undertake the installation of your system.

AUTOGRAPHIC CAMERA

(919) Edwin S. Warner, State College, Pa., has designed a device wherein a ground glass and an opaque slide are placed on the back of a camera. Writing to be impressed on the negative is done on the ground glass whereupon the opaque slide is removed for a short time, thereby exposing a short section of the film to the light and impressing the writing thereon. He asks our advice.

A. 1. No doubt the autographic attachment which you have devised would operate, but why add all this additional apparatus to the camera when the autographic films operated with a stylus, access to which film is obtained by means of a small opening in the back of the camera, do the work equally well if not better than your device?

Perhaps if you will give a reason for suggesting your apparatus, we could advise more fully.

PUZZLE

(920) N. Baker, New Bedford, Mass., submits a design and model of a wood block puzzle upon which he desires our comment.

A. 1. We have looked over your puzzle and have operated it according to your directions. We find it to be very interesting and absorbing.

The one draw-back to the applying for a patent of such a device is that it would be hard to get a manufacturer to make it for you. If, however, you are in a position to make this device cheaply and finance the manufacture of it yourself, we see no reason why you should not apply for a patent. You can have your specifications drawn up by a patent attorney and filed in the Patent Office. You can then proceed to manufacture the device yourself, stamping it "patent pending." Then in the course of a year, you can see how the sale of the device will go. At the end of that time you can judge for yourself just what the results will be. This is practically the only way to place such a device on the market, as very few, if any, companies are ready to finance the manufacture of puzzles.

WRITING AID

(921) H. Sheffel, New York City, has designed a stencil for use in teaching the child how to write. The child merely places the stencil on a sheet of paper and draws around it. He believes this is superior to the method of using a rack of metal in which the letters have been indented, and the child traces the movements with a pen or pencil until he becomes familiar with them. He also desires to know what he can do without finances.

A. It is very difficult to do anything at all without the necessary finances. In the first place, you cannot protect your idea sufficiently to warrant further work, and in the second place you cannot interest the manufacturers, unless you build working models to demonstrate the feasibility of your system, and you should also have the opinion of some teacher of writing who has studied the probable effect of your system on a class of pupils, and instructed half by means of the regular method, and the other half by means of your system.

We frankly do not believe that your system of teaching is superior to the regular grooved letters of which you spoke in your communication, inasmuch as in your system the individual does not form letters but draws around the letters. This is of no earthly use in teaching the youngster to write, as he would never under any circumstances go through so many moves in order to form a single letter, as are necessitated in your system of teaching.

We would most assuredly advise that you forget this idea, as you will find that whatever money you put into this system of teaching will, in our opinion, be hopelessly lost.

WRENCH

(922) W. F. Morgan, Chicago, Ill., submits a design of a quick action wrench wherein the worm on the lower or moving jaw can be released from the rack, allowing quick adjustment. He asks our advice.

A. 1. The wrench which you have designed is not new, except that instead of using springs for holding the gear in place, you also employ a trigger to release the gear. A monkey wrench of a similar nature has been found in New York, in which one merely pulls back on the worm, releasing it from the teeth of the wrench, after which the lower jaw may be slid in either direction, and then the worm gear is permitted to slip back in mesh with the rack on the fixed jaw and handle. This is a rather expensive method of doing the work, and it meets with several difficulties. In the event of an excessive strain upon the wrench, one of two things generally occurs. Either the worm gear locks itself fast into the toothed rack of the wrench so that it is almost impossible to remove it, or else the worm gear slips away from the teeth, due to weakness on the part of the springs.

For this reason an inventor has designed a monkey wrench in which a slit is cut transversely through the worm gear, and when the worm is turned into a certain position, it may be slid back and forth without engaging with the toothed rack. A slight eighth of a turn again meshes the gear and rack, and further adjustment is made with the worm. A bench vice of similar design has also been found upon the market. We would not suggest that you apply for a patent on your tool.

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Tarrano the Conqueror

(*Continued from page* 758)

"Master?"

"Send the message, Colley. Fling it audibly over Mars! Tell the rulers of the Little People that if they send up the green bomb of surrender—Tarrano will spare them further bloodshed. Tell them that I am not giving the Brende secret to Earth. In a moment I shall defy the Earth-Council. Promise them that the Brende secret is going to Mars. Assure them they will have everlasting life for everyone. . . . Wohl!"

"Master?"

"Give me the Cave Station."

The mirror went dark. Then came bright. A cavern in the interior of Mars. A dark scene of wavering yellow torches. Around a table of instruments sat a score of hairless men. Tarrano snatched up a mouthpiece—murmured slowly into it. I could see the leader of the hairless men nod after a time, as the message reached him. And I saw him turn away to issue swift orders as Tarrano had commanded.

Tarrano said brusquely: "Enough! . . . Wohl!"

The mirror went dark. A voice called: "Master, the green bomb has gone up from the Hill City! Do you wish to see?"

"No. . . . Give me Venus. Olgan! Are they quiet on Venus?"

"Yes, Master."

"Congratulate them that we have conquered the Little People. Tell them Mars is ours now! Tell them I am coming to Venus at once—with the Brende model. . . ."

"Master, you wish to see Venus? I have direct communication——"

Another voice interrupted. "The Earth-Council, Master! They demand an explanation of why you say the Brende model is going to Mars. You have promised it to Earth. They demand——"

Tarrano rasped: "Tell them to wait . . . I don't want Venus, Olgan. . . . Megar! Give me the Earth Mountain Station."

He turned to me, and his voice dropped again to that characteristic sardonic drawl:

"We must see how your friend Georg Brende is faring."

The mirror showed Georg, standing irresolute on the platform before the sending discs.

Tarrano called: "The Princess Maida—can't you locate her?"

The scene blurred momentarily, then showed us the outside of the Station. A white expanse of snow, with purple starlit sky above. From a side door of the building, as we watched, the figures of two women appeared. A woman leading Maida. As they came out, with Maida all unsuspecting, from the shadows a group of men pounced upon them—dragged Maida swiftly away.

Tarrano laughed. "Enough! . . . Show me Georg Brende again. . . . Hurry! Do you want me to miss his plunge?"

We saw Georg waver and leap through the window, fall into the snow, where, from the shadows of the building, other men rushed out upon him . . . hurried him away after the captive Maida. . . .

Tarrano's laugh was grim and triumphant. "Ha! We win there, also! Enough! Nunz? Nunz—now you can give me the Earth-Council! Where is it sitting? Washington, or Great-London?"

"Washington, Master."

"Very well. . . . No, never mind connecting me. You speak for me. Tell them I've changed my mind. The Brende model is not coming to Washington. Tell them Georg Brende is lost to them, also. Tell them I declare war! *Tarrano the Conqueror* declares war on the Earth! Tell them that, with my compliments. Tell them to come down here and overwhelm me—it ought to be very easy!"

End of Part VI—To Be Continued.

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Photo-Electric Eye Sorts Cigars

(*Continued from page 710*)

galvanometer as shown in the diagram. In this galvanometer the current is just heavy enough to swing the needle over a small arc. But the swing of the needle is divided into six major divisions, each of which in turn is broken up into five parts, and the whole 30 divisions thus made have each an interlocking terminal.

There is a *dog*, or extension catch, depending from the extreme end of the ammeter needle so made as to fit into the interlocking terminals of the 30 divisions of the switch. When the *eye* is viewing a cigar, the ammeter needle swings freely, until it comes to rest at a point on the scale corresponding to the current caused to flow through the potassium-terminaled tube. Then two jaws working from either side of the galvanometer switch close in and cause the *dog* on the end of the needle to make contact with the particular switch terminal located opposite the point at which the needle came to rest.

The switching device is so constructed that no contact is made between the swinging needle and the contact points corresponding to the 30 compartments of the table, until such time as the needle comes to rest. At that instant two locking jaws close in from either side, and cause contact to be made between the needle and the particular *dog* toward which the needle points; thus allowing a local current to pass, sufficient to energize the proper magnet to trip the rotating finger as it reaches the right compartment. The needle's motion is, therefore, unimpeded.

Feature Articles in December "Radio News"

The Regenerative Interflex Circuit. By Hugo Gernsback. The latest development of this interesting circuit is the addition of regeneration, making an efficient one-control receiver.

Thirty Years in a Dark Room. By W. B. Arvin. Biography of D. MacFarlan Moore, the maker of the first vacuum tube.

Britain's New Superpower Broadcast Station. By A. Dinsdale.

Transatlantic Telephony. By G. C. B. Rowe.

Multiple Grid Vacuum Tubes and Their Advantages. By Theodore H. Nakken.

After this a heavy current is passed through the needle, *dog* and proper terminal (the three closing the circuit) and it is this current which operates magnetic trips on a circular sorting table, causing the cigar (now being carried by troughs above this sorting table) to be passed unerringly into the proper compartment corresponding to its color.

One operator controls the entire machine, and the sole duty of this operator is to watch and see that no unforseen thing causes the machine to stop. The accuracy of the sorting is so perfect that inspection of the cigars in each compartment is entirely unnecessary. In fact, it is doubtful whether any human being could distinguish any difference in color between the cigars in any one compartment after this sorting.

The machine is not being sold, but is leased on a royalty basis; the amount varying with the number of cigars passed through the machine, as determined by acounter attachment.

Plans are under way now for the adaptation of this machine to the needs of several other industries where color selection plays a large part in determining the value of finished products.

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By JOSEPH FULLING FISHMAN

(*Continued from page 707*)

smile. A trick of the officers, he felt quite sure, to discourage any prisoner who might attempt it. It probably became wider again after a few feet. He smiled triumphantly after he had gone on a little further. The conduit did widen out to its original size just as he had thought it would. He hastened his progress as he knew it was but a few hundred feet to the little stream where the prison sewage had an outlet. Already he could smell the air of freedom and, busy as he was, he could not help speculating with amusement on the surprise of the officials when they found he had gone. His heart pounded as little streaks of light appeared, and a thrill shot through him as a draught of air struck him in the face. Funny though the streaks of air weren't larger. He did appear to be quite near now. Just about twenty feet more and he was free! He'd crawl through and——and——

With a muttered curse and with infinite difficulty he reversed his body and began the long, tiresome journey back to the prison, fervently hoping that his absence wouldn't be noticed. For in this battle of wits the officials had won. Inside the larger pipe and extending for a distance of about twenty-five feet to the end was a battery of twelve three-inch pipes through which no human being could possibly crawl.

AN INGENIOUS ESCAPE

The recent escapade of "Dutch" Anderson, for many years a pal of Gerald Chapman, the notorious bandit, brings to mind the method in which Anderson escaped from the Federal Penitentiary at Atlanta. Anderson was tubercular and occupied one of the tents used for the tubercular colony in the yard of the institution. These tents, about twenty in number, are about twenty-five or thirty feet from the wall surrounding the institution. These tubercular prisoners do no work at all, but simply "take the cure," being allowed all the milk and eggs they can eat. They are encouraged to get as much air as possible, to cultivate a large garden surrounding the tents and to do nothing outside of that except to nurse themselves back to health. The flaps of these tents are kept open during the day but are closed at night.

Anderson and two other prisoners decided to dig their way out under the prison wall. The wall is thirty feet high, the foundation running into the ground for a distance of about eight feet. Each tent is equipped with a large square rug in the center. This rug the prisoners used to conceal the hole which they begun to dig. The digging was done with a small shovel and pick, each about eighteen inches long. After they got down to a distance of about ten feet they started digging toward the wall. The hole which they made was large enough to admit a man's body. They would take turns in digging, lying flat on their stomachs and laborously digging and shoveling while in that uncomfortable position. The problem of disposing of the dirt was a difficult one but they solved this by continually digging and working in the garden in a large area, so that the dirt could be distributed without raising the level of the garden to a suspicious extent.

As the digging progressed it became more and more difficult to get the dirt back into the tent. Anderson solved this problem by building a small wagon out of pieces of wood which he picked up here and there. This wagon was moved with a piece of twine attached to a pulley at each end of the tunnel.

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But the man in the tent end of the tunnel would have to know when the wagon was full so that it could be hauled in and emptied. A signalling system was devised to solve this problem. A cord was run along the side wall of the tunnel. It was attached to the side with small staples placed in the wall about five feet apart. To each end of the rope was attached a small flag. When the man engaged in digging wanted to signal that the wagon was full he jerked the cord, which pulled upright the flag at the other end. The man in the tent end of the tunnel would then haul the wagon in and carefully distribute the dirt around the garden. He would then pull the cord on his end, when the other flag would be pulled upright and the man doing the digging notified that the wagon was empty and ready to be pulled back for reloading.

After months of the most laborious and back-breaking work the tunnel finally was underneath the wall. The prisoners decided to go at once, notwithstanding the fact that it was the middle of the day and that they might be seen as they emerged on the outside by one of the tower guards, who are always armed. But luck was with them. They emerged safely, brushed the dirt from their faces and hair and strolled away, being taken for one of the dozens of "outside trusties" who are seldom within the walls. This was the last heard of Anderson until a short time ago when a farmer, who is said to have "squealed" on Chapman, was murdered. On his death bed he whispered "'Dutch' got me!"

Important Articles to Appear In Dec. Issue of "The Experimenter"

The Story of the Bell Telephone.
By T. O'Conor Sloane, Ph. D.

The Evolution of the Vacuum Tube.
By Leon L. Adelman.

Sound and Audio Frequency Amplification.
By Theodore H. Nakken

Home-Made Geissler Tubes.
By F. Castro

A Practical Tesla Coil.
By Willis L. Nye

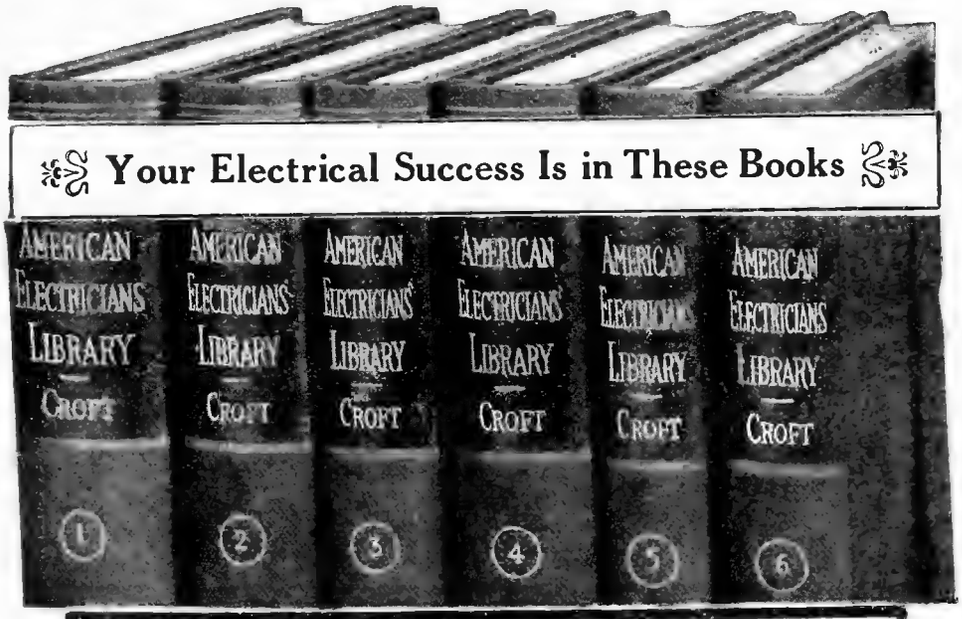
Chemical Fun With Light Rays.
By Raymond B. Wailes

The Specific Gravity of Solid Bodies

(*Continued from page* 730)

Sometimes we have to determine the specific gravity of substances which are lighter than water. In this case, as for instance with the samples of different woods, a cube of the material of exactly three centimeters on a side, can be cut out and weighed, Fig. 2. Its volume is of course 27 cubic centimeters, and if it weighs 20 grams, its specific gravity is found by dividing 20 by 27, which gives 0.74, or approximately ¾, as its specific gravity. This method can be also used for stones and the like if it is practical to cut them, but if the cutting out of a true cube is impossible, the volume of the body is determined by putting a knitting needle into it, assuming it to be lighter than water, and pressing it down into the water in the measuring cylinder and noting the rise of the water. The error due to the volume of the portion of the needle immersed may be safely neglected, but it can easily be allowed for if such accuracy is necessary.

Very often one has to determine the thickness of a thin wire. It is then best to determine its volume by a species of measure-



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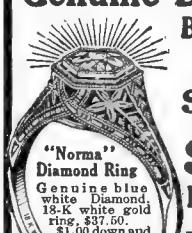

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ment, for if it is immersed in water or oil, a certain amount of air, some perhaps as visible bubbles, will adhere to it.

Referring to Fig. 3, the wire may be wound, say 20 times, around a lead pencil, and squeezing the convolutions together, the length they occupy is measured. Suppose the wire occupies a space of 65 centimeters, or say 2.6 inches, then our wire has a thickness obtained by dividing this figure by 20, which gives 3.25 millimeters, or about .125 inch. Squaring this gives us the cross-sectional area of the wire, and its length is then measured, and multiplying the cross-section by its length we get its volume. If this is done in the metric system, the cross-sectional area will come out 0.000825 square centimeter; if it is 78 centimeters long, its volume will be 0.06325 cubic centimeter. The weight of this piece of wire is too little to be accurately determined by our letter scales, so we will take ten times this length. Suppose it weighs 4.8 grams, then our short piece of wire weighs 0.48 grams, giving its specific gravity as 0.48 divided by 0.06325, which equals 7.7. We are supposed to have taken a bit of wire such as used by florists for mounting flowers.

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County of New York, }

Before me, a notary public in and for the State and county aforesaid, personally appeared Hugo Gernsback, who, having been duly sworn according to law, deposes and says that he is the editor of SCIENCE AND INVENTION, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

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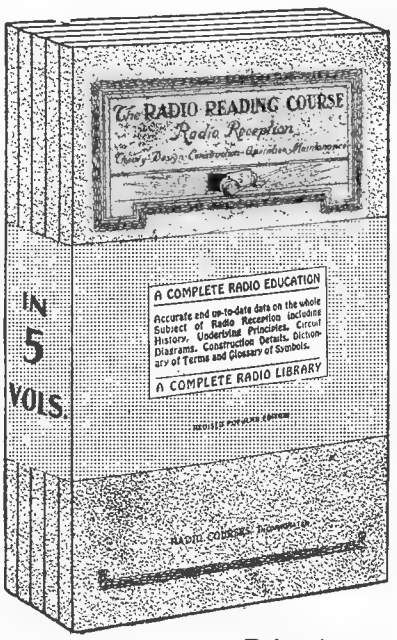
Sworn to and subscribed before me this 28th day of September, 1925.

(SEAL) JOSEPH H. KRAUS.

Notary Public, Queens County Register's No. 4523, New York County Register's No. 7364, New York County Clerk's No. 481. (My commission expires March 30, 1927.)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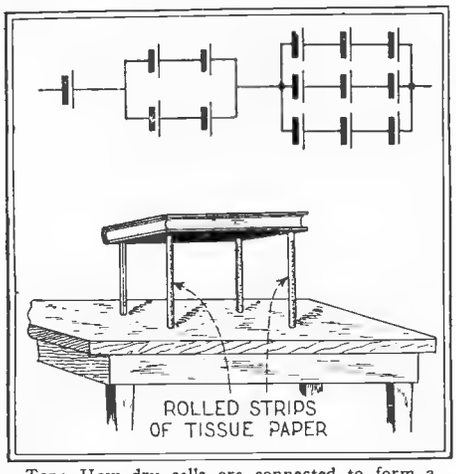
Answers to Scientific Problems and Puzzles

(Continued from page 726)

1. Diagram herewith shows 14 cells arranged so as to form a battery of 9 volts.

2. Ammeters A_1 and A_2 are connected in series with the rest of the circuit. Hence the same current will pass through both, and their readings should be the same.

A voltmeter reads the product of the current and resistance between its terminals. The resistance across V_1 consists of the entire circuit outside of the battery, *i. e.*, the two ammeters, resistance coil R and the connecting wire, whereas the resistance across V_2 is only R. V_1 therefore will read higher than V_2. However, since the resistance of two good ammeters and the connecting wire is small in comparison with R of 100 ohms the voltmeter readings would hardly differ by an appreciable amount.



Top: How dry cells are connected to form a 9-volt battery. Bottom: Supporting book with tissue paper.

3. Suppose for simplicity, that branch D is at first open while the circuit ABCE is closed. Then, by Ohm's law the current through E will be 6 divided by 1½, or 4 amperes. And the fall of potential across E will be 4 x 1 or 4 volts. But this exactly equals the E.M.F. in branch D, so no current can pass through it regardless of the resistance in this branch.

A more rigid proof:

By Kirchoff's law the sum of the separate falls of potential around a circuit is always zero. Let I be the current through ABC, I_2 the current from A to C through D, and R the resistance in D.

Then $6-\frac{1}{2}I_1-I_1-I_2 = 0$

Or $6-3/2\ I_1-I_2 = 0$ (1)

and $4-RI_2-I_1-I_2 = 0$

or $4-I_2(R+1)-I_1 = 0$ (2)

$I_1 = 2/3\ (6-I_2)$ from (1) (3)

$4-I_2(R+1)-2/3(6-I_2) = 0$ by combining (2) and (3)

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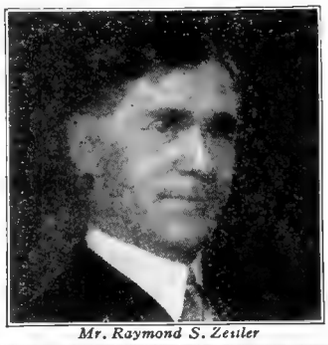

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$-I_2(R+1) + 2/3\ I_2 = 0$

Hence $I_2=0$ for any value of R.

4. Yes. As the cylinder is forced downward the air within it is compressed and the cylinder will displace less and less water. Eventually, it will reach a depth such that it displaces a weight of water less than its own weight, whereupon it will sink permanently.

5. Let D represent the diameter in inches of the band before it is lengthened. Then

$$\frac{\pi D + 36}{\pi}$$

will be the diameter after its circumference is lengthened by 36 inches. The change in diameter thus produced will be

$$\frac{\pi D + 36}{\pi} - D \text{ or } \frac{36}{\pi}$$

inches. And the possible elevation all around will be half of this or $\frac{18}{\pi}$ or about 5.7 inches.

Thus it can be seen that the elevation would be the same whether the earth were as large as the sun or as small as a pea.

6. The most economical size for a cylindrical can closed at both ends is one in which the height just equals its diameter. It then has the greatest possible volume for the amount of material used in its construction.

7. Let X be the distance of the rear car from B when the pier A gives away. Then by the principle of moments

$3{,}500\ X + 3{,}500\ (100 + X) = 5{,}000 \times 200$

from which X turns out to be nearly 93 feet.

8. When the sound from the organ pipe strikes a resonator, some of the sound enters through the opening and is reflected by the walls until it reissues from the mouth of the resonator. In the act of reflection a reaction is produced which will cause the resonators to rotate in a clockwise direction provided the friction of the bearings is not too great.

9. Divide the sheet of tissue paper into four equal strips and roll them into compact cylinders. The book may then be balanced upon them in the manner shown.

STAR MAPS

Quite a few of our readers are interested in maps of the heavens showing the constellations and where to find them. Due to the large number of subjects covered by SCIENCE AND INVENTION every month, and as there seems to be more of a need of the Star Maps in our sister publication, MOTOR CAMPER & TOURIST, these appear only in that publication at this time, and we gladly recommend the attention of our readers to MOTOR CAMPER & TOURIST.

IMPORTANT

TO NEWSSTAND READERS

IN order to eliminate all waste and unsold copies it has become necessary to supply newsstand dealers only with the actual number of copies for which they have orders. This makes it advisable to place an order with your newsdealer, asking him to reserve a copy for you every month. Otherwise he will not be able to supply your copy. For your convenience, we are appending herewith a blank which we ask you to be good enough to fill in and hand to your newsdealer. He will then be in a position to supply copies to you regularly every month. If you are interested in receiving your copy every month, do not fail to sign this blank. It costs you nothing to do so.

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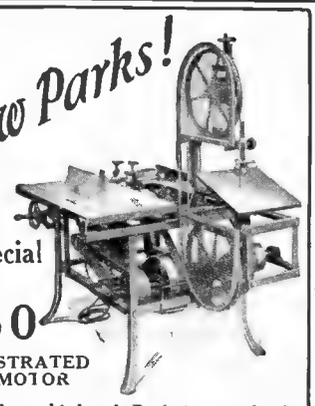

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WRNY Plan Expands

By CHARLES D. ISAACSON

(*Continued from page 737*)

"Waltz Song" from Gounod. It would be impossible to list all the old-time songs by Anna Russo, as she is selecting from every school.

The Lullaby Lady, Kathryn Behnke, like the old-time song girl, chooses her selections from all types of music.

Sigmund Spaeth has shown most interestingly how the simplest kinds of melodies have developed into great music and has shown how some of our popular music of today, changed in characteristics, could sound almost like great music, also he has shown how great composers would handle some of our simplest themes like "Yankee Doodle."

In the violin series, Samuel Polonsky has done fine work. His selections have included many Kreisler numbers and special arrangements of old themes and Hebrew melodies.

The world of chorus was well represented by the Clara Novello Davies singers in selections from oratorios and by the fine Irving Quartette, with Meta Christensen as its sponsor and leader.

Among the novelties presented at WRNY on Fridays was the broadcasting from the Woolworth Building at noon, six o'clock and ten in the evening. A seance was held in the studio one evening and on another evening ghost stories were told.

SPECIAL FEATURES

One of the interesting special events was the celebration of the 42nd Street Association, which brought, among others, the motion picture actress, Evelyn Brent; Josephine Duval, of "Not So Long Ago"; Sidney Machot, of "Outside Looking In"; Miriam Lax, of the Rialto; Anna Dale, of "The Fool," and such speakers as Louis Wiley, of the *Times;* Julius Kugelman and the Hon. Travis Whitney.

The English Speaking Union dinner was broadcast. John W. Davis, the Rt. Hon. Sir Robert Horne, Capt. H. Arthur Evans, F. W. Pethwick-Lawrence, Esq., and Major-Gen. Sir Robert Hutchinson were among the speakers at this banquet.

The Near East Golden Rule dinner was also broadcast. The principal speakers were Dr. John Finley, Bishop James Cannon, Hamilton Fish, Jr., and Charles Vichrey. Dr. S. Parkes Cadman also made a short address.

The Experimenter

has come back! If you are one of the one hundred thousand readers of the old ELECTRICAL EXPERIMENTER, you will no doubt be glad to hear that the EXPERIMENTER is coming back BIGGER AND BETTER THAN EVER. PRACTICAL ELECTRICS has been changed into an entirely new kind of magazine entitled

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Be sure to reserve a copy from your news-dealer before the issue is sold out. The next issue of THE EXPERIMENTER will be on sale at all newsstands beginning November 20th, 1925.

Hugo Gernsback
Editor

Safeguarding the lanes of speech

The New York-Chicago telephone cable has been completed and is now in service. A triumph of American telephone engineering, the new cable is the result of years of research and cost $25,000,000 to construct. Its first reach extended along the Atlantic seaboard, then steadily westward until this last long section to Chicago was put into service.

To the public, this cable means dependable service irrespective of weather conditions. It is now not likely that sleet storms, which at times interfere with the open wire type of construction with 40 to 50 wires on a pole, will again cut off the rest of the nation from New York or from the nation's capital as did the heavy sleet storm on the day of President Taft's inauguration.

The new cable means speedier service, as it provides numerous additional telephone circuits and will carry a multitude of telephone and telegraph messages. It would take ten lines of poles, each heavily loaded with wires, to carry the circuits contained in this most modern artery of speech.

This cable, important as it is, is only one of the Bell System projects that make up its national program for better telephone service to the subscriber. It is another illustration of the System's intention to provide the public with speedier and even more dependable service.

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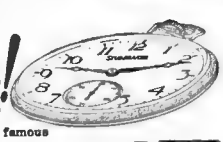

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Matchcraft—
The Latest Craze

(*Continued from page* 705)

is easier to handle. After the antenna was put in place, it was silvered with an ordinary aluminum "silver," which gives the antenna a sparkling appearance when held under the light. The foliage is the ordinary type of grass used in aquariums. Tiny holes are punched into the wooden board underneath to permit of the insertion of the stems. The green lawn is ordinary green blotting paper. In this case the towers were painted with a metallic silver paint.

Fig. 12 shows a small radio set built of matches; buttons serve as dials and green silk thread is used for the wiring of the loop. The loop is cemented fast to a button.

The beautiful windmill, illustrated at Fig. 13, was built by Mr. Joseph F. Odenbach, also of the staff of SCIENCE AND INVENTION Magazine. The matches for the tower and the top were first laid down. Then the structures for the edges of the vanes of the windmill were built and inserted into a cork, which was mounted on the end of a knitting needle. The vanes were then cross-braced, care being taken that they had a sufficient rake. The matches were then glued in place on the vanes, and when they were dry the entire device was assembled. When this is held in front of an ordinary electric fan the windmill revolves quite rapidly.

A working model of a derrick was built by Mr. A. P. Peck. This is shown in Fig. 14. The boat and the house were both built separately. By employing the foundation principle described in the construction of the bridge, the girders for the shovel were built as previously intimated. The chimney was made entirely of matches which were cemented together, using a pencil as the form upon which the matches were laid. A rubber band was then strapped around the matches forming the chimney to hold them in place while they dried, and after they were dried the pencil was removed. A pin was then driven into the pole and the house mounted upon it, which permits the house to swing back and forth. Pieces of cheesecloth soaked in plaster of Paris were then dropped upon the nails to give the wave effect and thick plaster of Paris was then molded in place to finish the wave formation. Note particularly how realistic these waves seem. The shore was made of plaster of Paris, upon which bird gravel was sprinkled, while the plaster was still wet.

From the above information, the construction of these match novelties will be apparent. It is now up to you. You probably have a little more time at your disposal than the editors of this publication have. Nevertheless, it will be worth your while to spend a few dreary evenings on Matchcraft. You may elaborate on the ideas presented in this publication and build a device of a similar nature to those illustrated by us if you should so desire. **You need not decorate your model or lend realism to it by using plaster of Paris or other backgrounds, as it is merely those items made entirely of matches which will be looked upon by the judges in making the award. Remember that matches must constitute 90 per cent. of the model.** You may use any kind of glue you desire and may do anything with the matches that you care to. They may be cut, drilled or bent.

Match tricks, that is, that variety of tricks where matches are laid loosely on a surface to form puzzling combinations, geometrical designs, etc., are not eligible in the Matchcraft Contest.

Incidentally, the editors have discovered that Matchcraft is a very fascinating pastime. You actually have no idea how fascinating it is until you have tried it.

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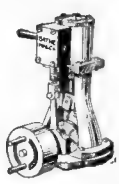

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Book Review

THE PRINCIPLES OF REASONING, by Daniel Sommer Robinson, Ph.D. Hard covers 5¼" x 8¼", 390 pages. Published by D. Appleton & Co., New York City. $2.50.

The reviewer admits, perhaps with shame, that he never studied logic as such. In this work we have a thorough development of logic and of the syllogisms, which often seems so puzzling. We can simply say this much about the book, that if anybody wishes to really study, what is called the science of logic, he can spend many hours on this interesting treatise. Hardly anything seems to be omitted from its pages, and a useful bibliography is given at the end, followed by a six page index.

THE FINGER PRINT INSTRUCTOR. By Frederick Kuhne. Hard covers, 6" x 9¼", 155 pages. Published by Scientific American Publishing Co., New York City. $3.00.

This work is a thorough treatise on finger printing, naturally with special reference to the courts and to the police. All details are given. The classification on which the whole subject is based, the practical details of the case, the very simple apparatus required, and the method of taking the finger prints, are all given. As an example of the details, even the subject of how to get impressions from people having missing, deformed or bandaged fingers as the caption puts it, is considered. Here a special classification is required; even oddities with their classification are considered.

Then the second part goes into the subject of filing the imprints which is very elaborate. The preparing of magnified views of finger impressions for use in the courts in police cases is treated with a number of examples. The claim is made that a finger print made accidentally on glass can be powdered and photographed three months after it is produced, which is a very important point in the way of testimony in court.

Part three gives a list of questions and answers, which type of instruction for some reason or other has really proved very popular. One hundred and ninety-five illustrations of finger prints follow the question and answer department, and the book closes with an index, which latter is quite adequate.

EYELESS SIGHT, by Jules Romains, translated by C. K. Ogden. Hard covers 5" x 7¾", 251 pages. Published by G. P. Putnam's Sons, New York City. $2.00.

If all that this book claims and describes were true, the spiritualist might be in danger of going to the rear. The idea is that things can be seen under definite conditions without the use of the eyes. There seems to have been some very spirited discussions about it in France, about the subject of extra-retinal vision, as it is called, and the claim is made that now it has become a branch of real study and open to serious investigation. The book certainly seems to have a curious aspect. Once extra-retinal vision is believed in and accepted, then this book will prove for those interested a very valuable treatise.

CONSCIOUS AUTO-SUGGESTION, by Emile Coué and J. L. Orton. Hard covers 5" x 7¼", 211 pages. Published by D. Appleton & Co., New York City. $1.25.

This book treats of what is called Couéism in the different stages of life. The reader will remember the invasion of this country by the French apothecary who claimed that disease could be cured by psychical methods. Those who are interested in it will find in this book considerable matter to interest them, and its application to the school room and education in moral reform are given. An instance for its application is for the relief of stage fright. The trembling subject is supposed to before going on the stage repeat over and over rapidly, "I have no funk," and thus come out on the stage perfectly self-possessed.

MECHANISM, LIFE AND PERSONALITY, by J. S. Haldane, M.D., LL.D. Hard covers 5" x 7¾", 152 pages. Published by E. P. Dutton & Co., New York City. $2.00.

Dr. Haldane has a way of perpetrating small books which have a way of becoming somewhat abstract, and we cannot lose the conviction that Dr. Haldane thinks that his conception of things are about right. The lazy way of reviewing a book is to use the contents and the index. The contents of this book consists of four lines and there is no index. We fear that it will not be popular in Dayton, Tenn.

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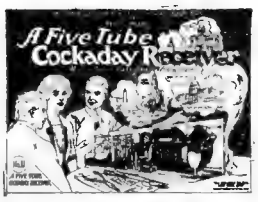

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The Radio Constructor

By A. P. PECK

(*Continued from page* 742)

and shape shown and bent near one end. Only chemically pure aluminum should be used and the plates must be perfectly clean before being placed in the solution. Sandpaper after scraping thoroughly and preferably clean in hot lye solution. Caution here as the lye will inflict serious burns if allowed to come in contact with the skin. Before you start to cut up and clean the electrodes, mix up enough of a saturated solution of borax in water to fill all of the jars in the entire rectifier. Allow this to stand for 24 hours and then fill the jars with the clear solution, leaving any of the borax that may have settled at the bottom of its container. The number of jars in the rectifier depends entirely upon the amount of voltage being used. Allow approximately 50 volts from the transformer for each jar in the rectifier. For 500 volts, use 10 jars on each side of the line, hooking them up as shown in Fig. 11B. After the strips have been bolted together and placed in the jars, fill each jar with solution to within one-half an inch of the top. Then pour a layer of oil about one-quarter of an inch thick on the top of the solution. This effectively prevents evaporation. Ordinary machine oil of a good thin grade can be used for this work. By using this precaution, the solution in a rectifier need never be renewed until the elements have to be taken out for cleaning which usually need not be done oftener than every six months.

THE FILTER SYSTEM

Rectified A.C. is by no means D.C. and it must be smoothed out somewhat in order to be satisfactory for use in transmission. This is done by means of a filtering system which consists of an iron core choke coil and high capacity condensers used in a circuit such as that shown. These instruments are indicated by 15 and 16 on the diagram and the photograph. In making a choke coil, a core very similar to that used in a transformer is employed with the exception that an air gap about 1/32nd of an inch wide should be left in one leg of the core. This can be done by placing a strip of cardboard of that thickness in position and binding the core tightly with clamps. The details for a suitable choke coil are as follows. The legs of the core should be built up of silicon steel strips .014 inches thick by 1.5 inches wide. The resulting core should be 1.5 inches high. The inside dimensions should be 4 inches by 3 inches, and the total number of turns should be 12,500. No. 26 wire should be employed and half of the winding may be placed on each of the longer legs of the core.

It is almost impossible to make satisfactory filter condensers and, therefore, you should purchase them. Two having a capacity of 2 mf. may be used or four having a capacity of 1 mf. may be connected in the circuit as shown in Fig. 2.

The rest of the necessary details for the construction of this complete transmitter can be seen from the various diagrams and photographs. The tuning is something that can only be learned by practice. For a starter, we would advise using two turns between the grid and filament clips and the rest of the oscillator inductance between the filament and plate clips. Vary the condenser until the milliameter reads quite low and check wave with wavemeter.

Then put the clips on the antenna inductance and vary the antenna and counterpoise circuits until the antenna meter shows a reading. With the antenna and counterpoise condensers, bring the antenna meter

(*Continued on page* 781)

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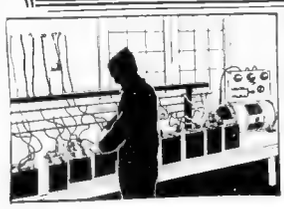

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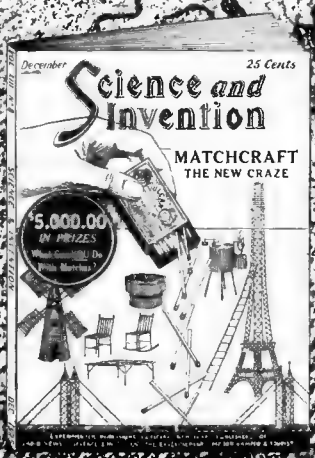

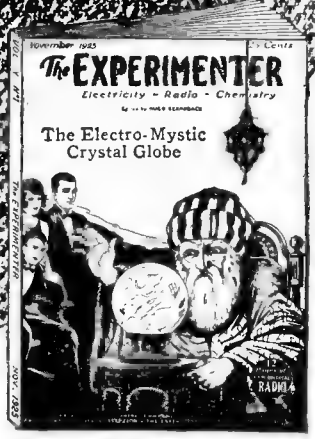

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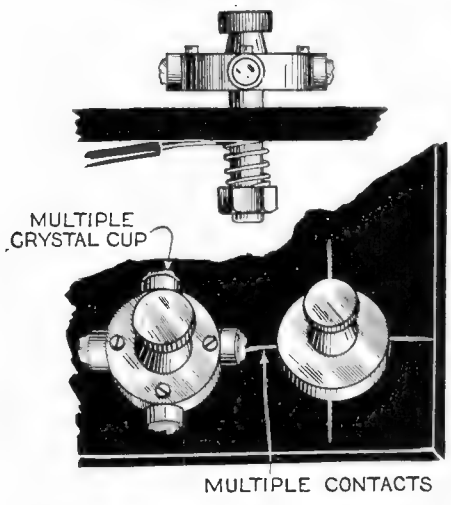

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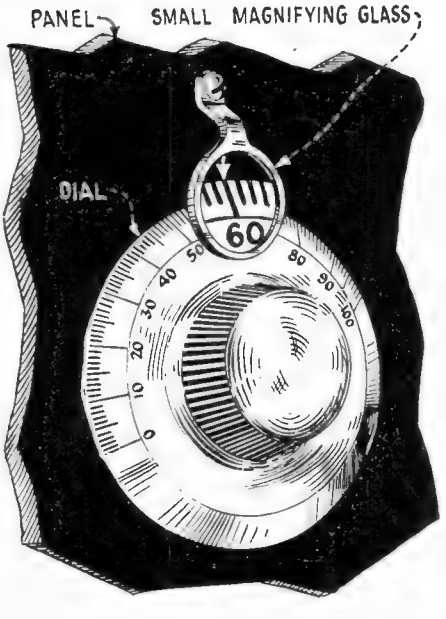

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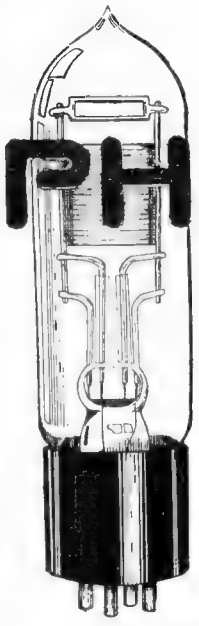

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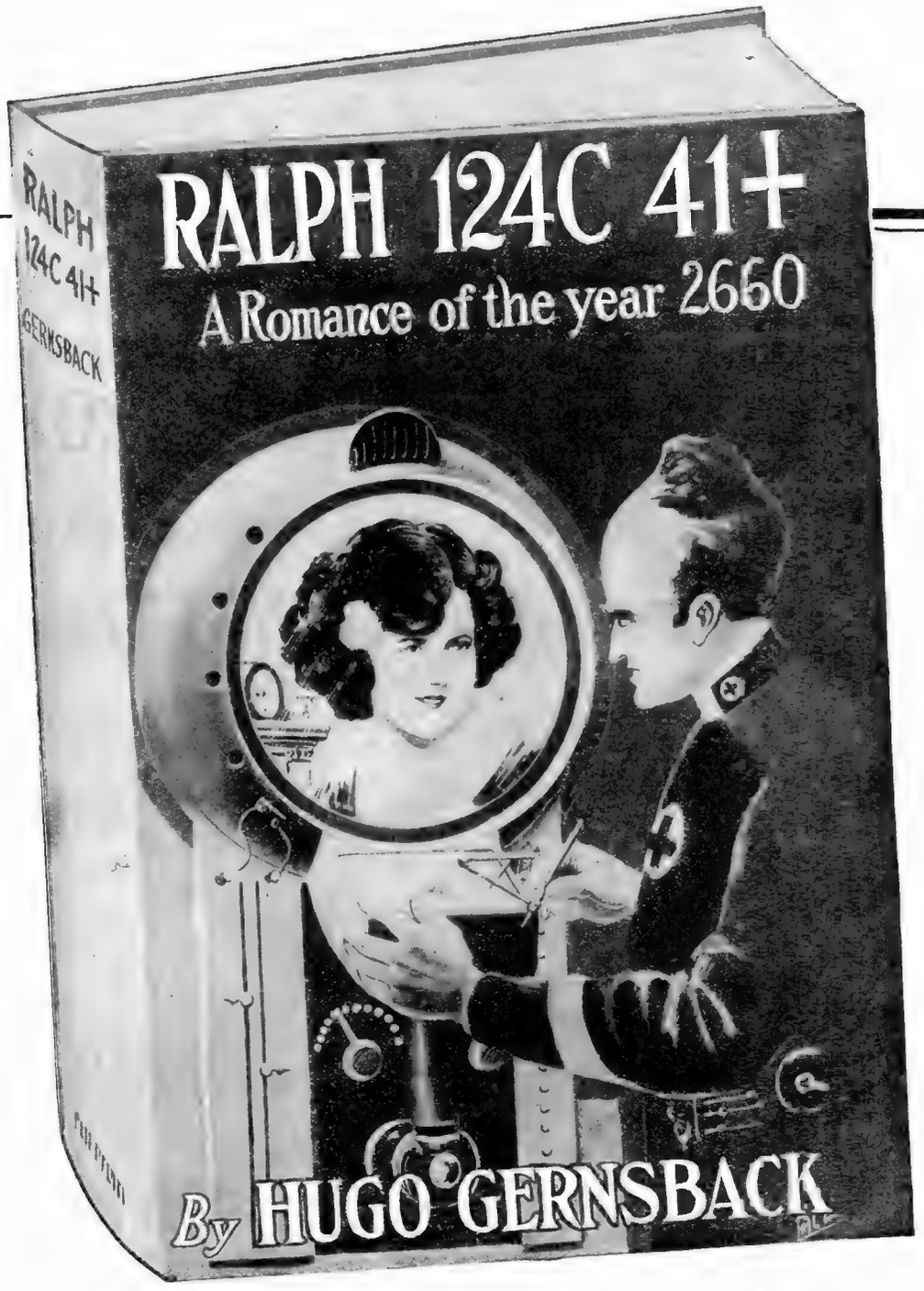

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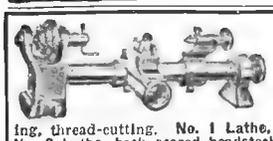

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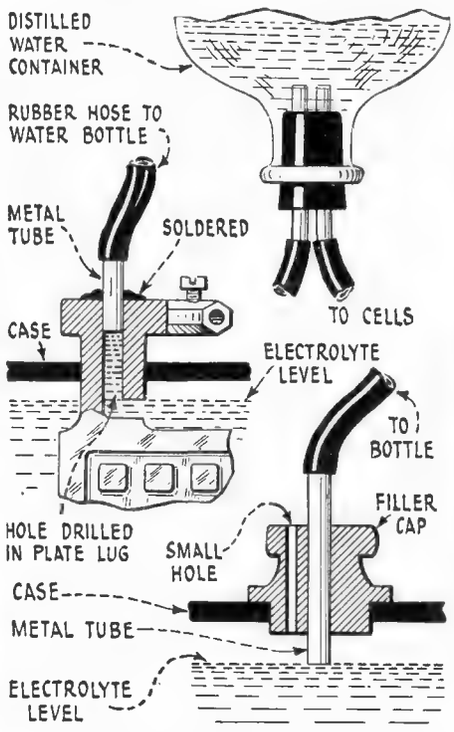
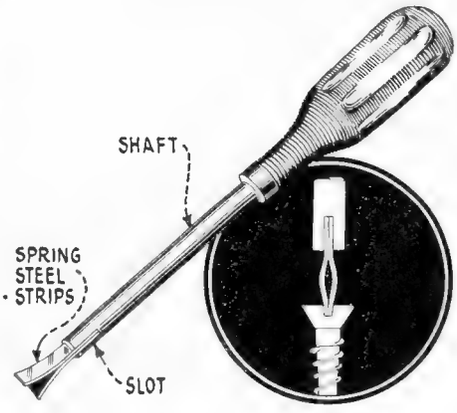
Automatic Storage Battery Filler



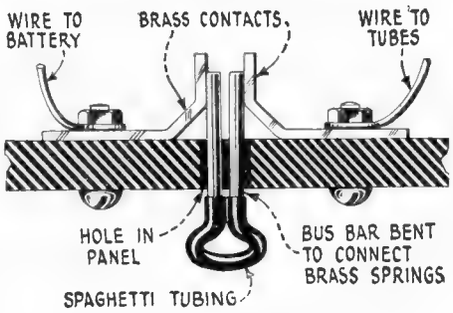
The electrolyte in a storage battery can be kept at constant level if an inverted distilled water container is placed at a point higher than the battery and is equipped with tubes, one running to each cell of the battery. Two methods of allowing the water to enter the battery are shown. All tubes must be air-tight. —J. Bront.

Screw Driver



A screw driver that will hold a screw while it is being started in an accessible place is made by using two spring steel strips as above. —J. E. Tewksburg.

Switch



A simple "A" battery switch is made from two brass contacts and a length of bus bar bent as shown. —Robert Aaron.

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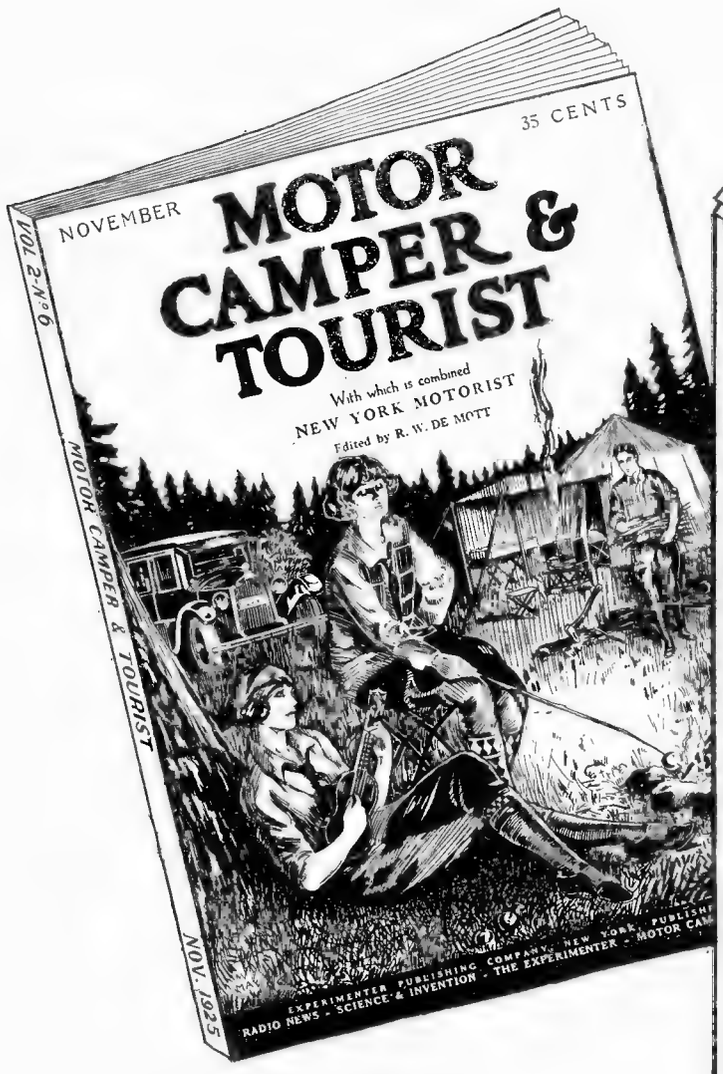
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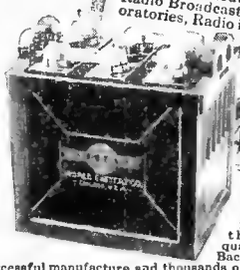

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Motor Hints

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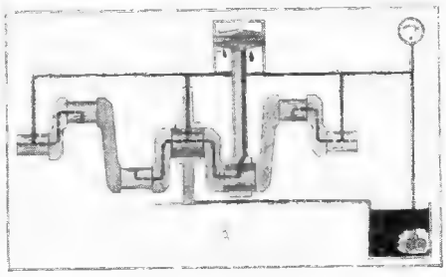
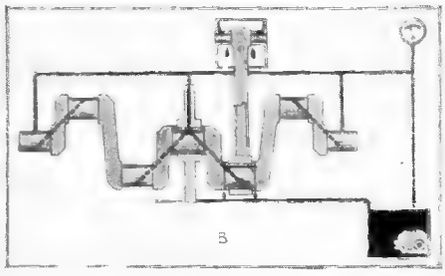
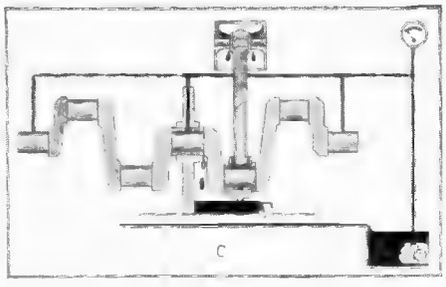
Lubrication Troubles



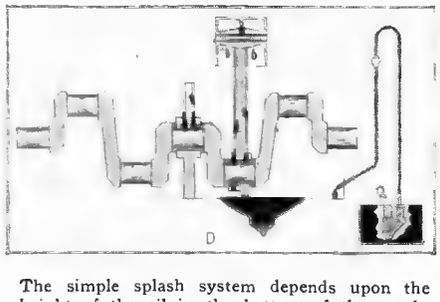
In Fig. A above we illustrate a full forced feed system of motor lubrication. A pump forces oil through the hollow crankshaft to the main bearings and then to the connecting rod bearings and up the side of the connecting rod through a tube to the wrist or piston pins. Black lines show the course of the oil.



In the forced feed system, the oil is only forced to the main bearings and to the connecting rod bearings as in Fig. B above. The piston or wrist pins and the cylinder walls are lubricated by the oil splash from the crankcase.



In the splash-pressure system, the oil is forced to the main bearings only. The connecting rods pick up their oil from troughs into which fins, spoon-like projections on the bottom of the connecting rods, dip. The troughs are filled by the pump and the rest of the engine is lubricated by oil splash.



The simple splash system depends upon the height of the oil in the bottom of the crankcase into which fins on the connecting rods dip. This is shown in Fig. D above. The oil level in the crankcase must be maintained by filling before running or by a special pump and an outside oil tank.

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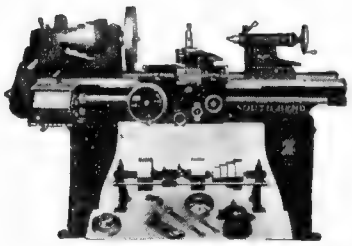

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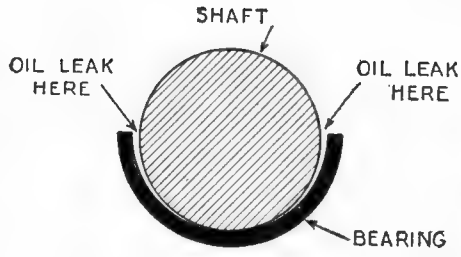
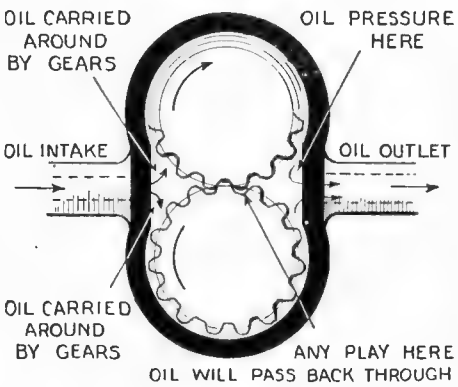
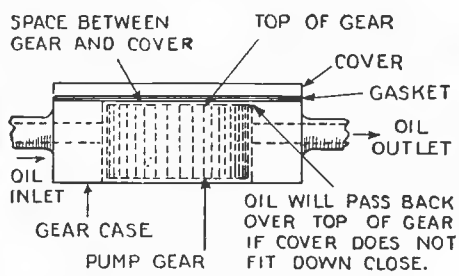


E

Oil becomes thin during service and should be changed every 500 miles. This is particularly true in winter-time because of the steam which is a product of combustion and which gets down into the crankcase in the form of water. On all pressure oil systems there is an oil gauge which will indicate whether the system is working correctly. Low oil pressure may be due to one of several troubles or to a combination of all or several. Thin oil will cause low pressure. Worn bearings as in Fig. E will give the same indication because the oil will leak out around the shaft.

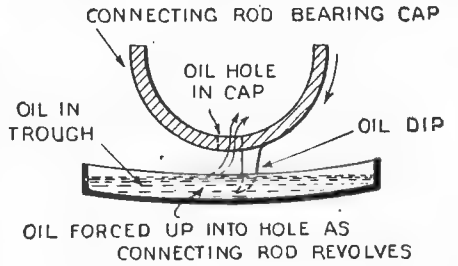

OIL CARRIED AROUND BY GEARS
OIL PRESSURE HERE
OIL INTAKE
OIL OUTLET
OIL CARRIED AROUND BY GEARS
ANY PLAY HERE
OIL WILL PASS BACK THROUGH TEETH BECAUSE OF PRESSURE AT OUTLET POINT.

F



F

Two other causes of low pressure are shown in Fig. F above. If there is play in the teeth of the gear pump, the oil will not flow properly and the pressure will be low. If the cover on the gear case is not tight, there will also be a lack of pressure. The remedies are obvious. New gears in the first case and a new gasket or tightening of the cover in the second place.



G

In the splash-pressure system, the connecting rod bearing cap should be placed in such a position that the oil will be forced up through the hole by the action of the oil dip. If the cap is on backwards, lubrication will not take place and burned out bearings will result. This is plainly seen in Fig. G. above.

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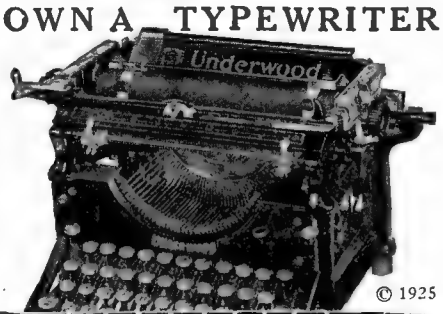

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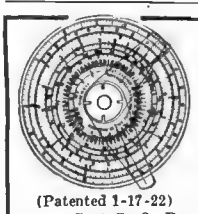

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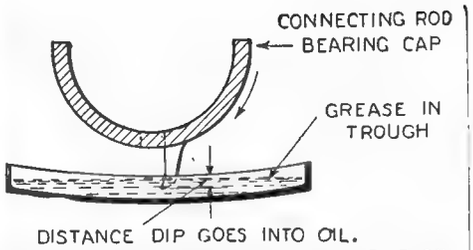
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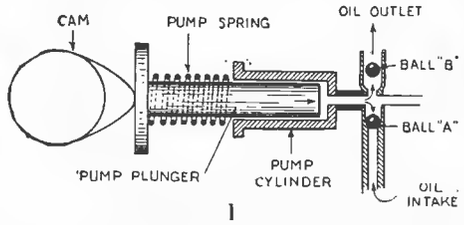
H

Sometimes the oil dip in a splash system does not go deep enough into the oil trough. To test this, fill the trough with grease, put into place and revolve the engine. The distance that the dip cuts into the grease will indicate the depth that it dips into the oil. Remove grease before assembling engine.



I

Some force-feed systems use a plunger pump of the type shown in Fig. I. If the pump plunger becomes worn, it will not operate correctly. Furthermore, dirt or grit around either ball A or B will reduce the pressure in the system by not allowing the balls to seat properly.

The Radio Constructor

By A. P. PECK

(*Continued from page* 773)

up to the highest possible reading. The circuits are now in full resonance but the transmitted wave will not be absolutely steady. This unsteadiness is not desirable and, therefore, one or the other of the antenna circuit condensers should be tuned slightly until the antenna meter reading is at a point that shows about 9/10ths of the highest obtainable current. The antenna circuit is now slightly off resonance from the oscillator and not quite as much power is being put into the antenna, but nevertheless, you will "get out" better because of the fact that the note and wave will be much steadier. All of this time, keep the filament volt-meter at the proper reading and watch the tube for signs of overheating. A sudden rise in temperature of the plate of the tube usually denotes that the circuit is out of oscillation. The circuit is also not oscillating when a variation in the oscillator tuning condenser does not cause the plate ammeter to change. From these few hints about the tuning and with a little practice, you should encounter no serious difficulty in getting your set to work. After you get on the air with it and communicate with two or three of your fellow hams, you will be able to tune the transmitter to its most efficient point. It may take days and even weeks to do this, but you will eventually arrive there and will be able to tune your set to any wave that you may desire to transmit upon.

(Author's Note: In case any readers are not sure as to where various instruments suitable for radio transmission can be purchased, the writer will be only too glad to help them upon request if they will address him in care of this magazine. Enclose a stamped addressed envelope and state just what instruments you wish to purchase.)

[*By* WILLIAM R. DURGIN]

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* * *

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* * *

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* * *

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Name .....

Address .....

City ..... *State*.....

AmericanRadioHistory.Com

Ozarka Senior Console—$197.50 East of Rockies
Complete with Tubes, Batteries and Speaker

A Good Wife and a Good Radio Assures Lasting Satisfaction

A LITTLE more time, a little more care in making the selection in the first place generally tends to more lasting satisfaction.

Out of every 100 Ozarka's sold in 1922 only eight are not today in the hands of the original owners—this does not include 17 out of each 100 who have purchased later Ozarka models in newer type cabinets. If there is a single Ozarka that is not in active service today, we have never heard of it.

Without the Ozarka Service in charge of direct factory trained representatives, such a record would not be possible. Ozarka service can be had today in almost every country. Purchasers in South Africa, Alaska, Sweden, Newfoundland, New Zealand, and Japan all receive the same practical service as those in Canada, United States, Mexico and Cuba. Whenever you find the sign of the Ozarka long distance goose, you'll find a man who knows Ozarka instruments perfectly.

If such service added more to your cost price it might be a matter to consider, but it doesn't. Quality for quality you'll find Ozarka prices lower—four tube Ozarka's with built-in loud speakers retail for $58.00—five tube with built-in speaker $64.00, up to solid walnut console design, $160.50.

Our nearest representative will gladly set up an Ozarka in your home, without any obligation whatever. He won't tell you what it will do—he will let you do all the tuning. With the Ozarka you must satisfy yourself, as to distance, tone, volume, ease of tuning and selectivity.

More than this you will be very agreeably surprised at Ozarka prices—selling as we do, thru our own direct factory representatives, our selling expense is very low—we give Ozarka purchasers the benefit of it.

Where is there a value to compare with the one shown above — solid walnut cabinet (no walnut finish or veneer), imported English loud speaker of a marvelous tone, five tube instrument with 75 ampere Exide storage battery, 90 volts of Eveready "B" battery, 5 tubes, aerial equipment all erected and the price is only $197.50.

A Few More Men are Needed to Sell Ozarka

In a great many counties we have the man we want. He is rapidly building up a permanent and profitable business of his own because he has an instrument that will more than meet all competition. More than this, he is trained to back up his sales with the kind of service that counts.

Many well established Ozarka representatives started by giving us only their spare time—their evenings. If your county is open you can do the same.

The investment in cash is very small. The investment in time necessary for study is considerable. It requires patience, but the results have enabled many men to get out of the salary and time clock class.

Any previous sales experience is helpful but not necessary. We can and will teach you how to sell.

Send for 84 Page Book—"The Ozarka Plan"

This book is entirely too expensive to be sent out on postal card requests. It will be sent FREE to any man who mails the coupon below and who is really anxious to improve his condition. Tell us about yourself—ask for Ozarka Plan No. 100 and don't fail to give the name of your county.

OZARKA INCORPORATED

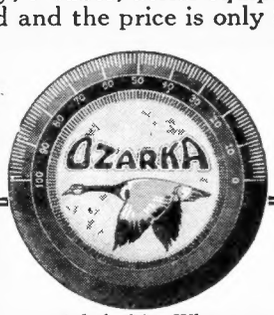
122 Austin Avenue K
Chicago, Illinois

Gentlemen: Without obligation send book "Ozarka Instruments No. 200" and name of Ozarka representative.

Name.....

Address.....City.....

County.....State.....



Ask the Man Who Wears this Button

OZARKA INCORPORATED

122 Austin Avenue K
Chicago, Illinois

Gentlemen: I am greatly interested in the FREE book "The Ozarka Plan No. 100," whereby I can sell your radio instruments.

Name.....

Address.....City.....

County.....State.....

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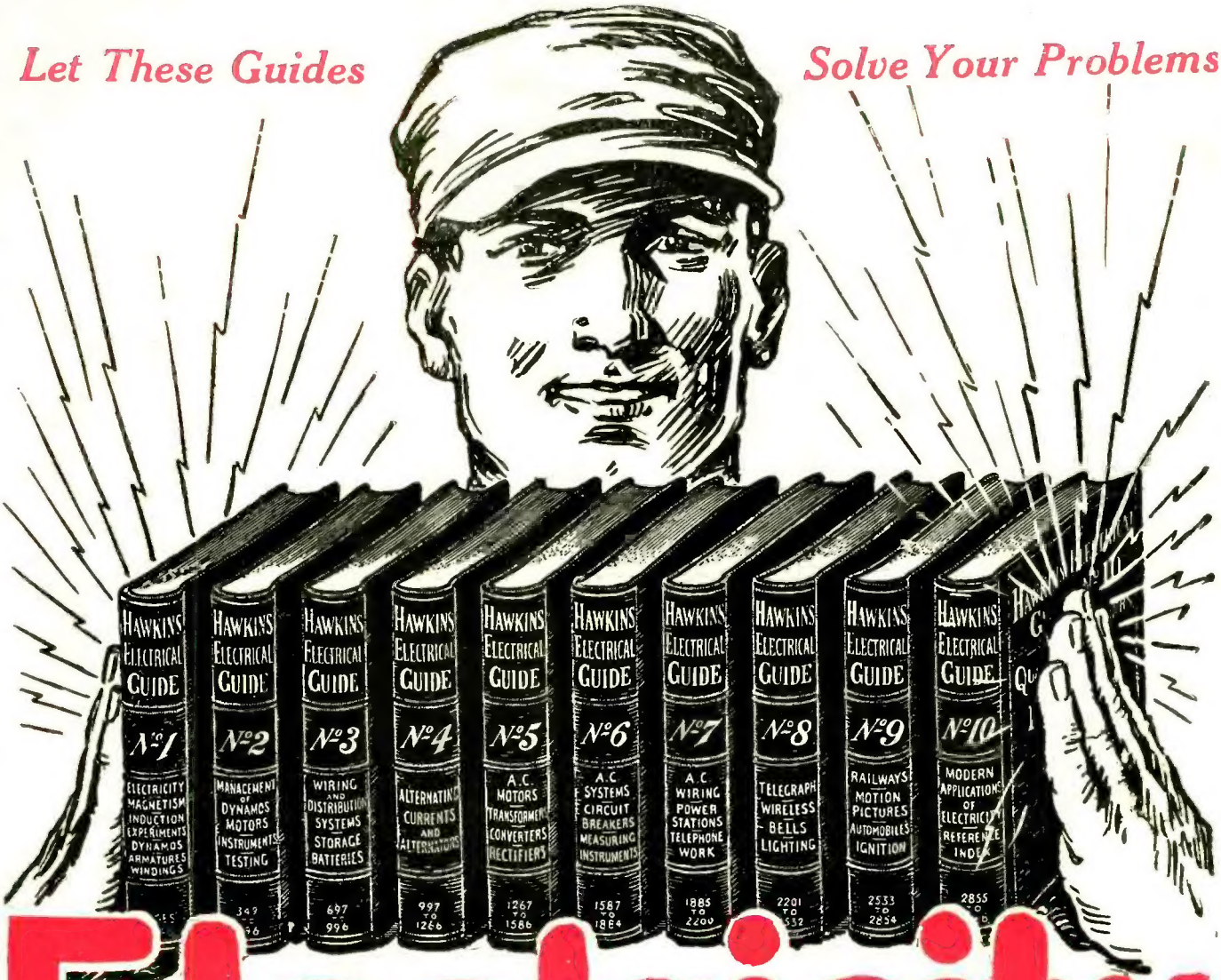

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65 West 23rd Street, New York City

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Name .....

Occupation .....

Employed by .....

Home Address .....

Reference .....

S.I., December

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Directing Engineer
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22 year old John F. Plow, Box 370, Ironwood, Mich.—still in the earliest part of his training—writes that he has averaged $30 a week EXTRA MONEY over his regular pay. But Mr. Plow is **only one of hundreds.** Think of it—how would **you** like a fine quick $30 a week raise! That's the kind of opportunity Cooke "Job-Way" offers you! Mr. Plow says: "I can't get away without **thanking you for it.** Your course is ONE in a million and I'll back up my statement with anybody."

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Speaking of Pay Raises—look at this! Joseph Woronecki, 186 Aflick St., Hartford, Conn., was making only $21 a week when he wrote me. Just four months later he wrote that he made **$300 in one week** in his own garage! That's an example of how **quick** my training gets amazing results. **Find out what it can do for you. Get my Free Book today!**

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